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ORGANIZATION OF THE TELEOST BLASTODERM

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THE teleost blastoderm has been subjected, during recent years, to several series of experimental analyses, carried on for the most part independently, by investigators working on three different Continents. Since the results of these various groups of investigations have never been included in a single summary, it seems well at this time to attempt to evaluate the results of the separate programmes as they appear when they are considered in relationship to one another.

Many of the experiments which have been performed on the eggs of bony fishes have been repetitions of similar experiments performed previously on amphibian eggs; their results have been in general the demonstration that the teleost follows the same fundamental pattern of development as does the amphibian. Some of the experiments, however, that have been performed on the fish embryos have had no exact counterpart in amphibian embryology; these have in some cases demonstrated the existence of mechanisms which are not characteristic of amphibian embryos, and indeed of developmental processes which in some cases vary among different types of teleosts. The following summary of the development of the teleost, pointing out known comparisons and contrasts between fish and amphibian on one hand, among different teleosts on the other, is presented at the present time out of the deep conviction that the new developmental physiology may accelerate its progress into the future as well by analyzing mechanisms which differ in different forms, as by emphasizing similarities among them.

SOME PERTINENT FEATURES OF THE DEVELOPMENT OF THE BLASTODERM AS A WHOLE

The most numerous of the experimental studies on teleosts have been carried out on the eggs of *Salmo* (primarily *S. fario*, the brook-trout, to a lesser extent *S. iridaeus*, the rainbow-trout) in Belgium and Germany, and on the eggs of *Fundulus* in this country. Before proceeding to an analysis of the experimental data on developmental potencies in these forms, it may be well to review certain aspects of the development of the whole blastoderm.

Normal development

The teleost egg, it will be remembered, is characterized by a relatively large fluid yolk surmounted by a blastodisc. The yolk, confined by a plasma membrane continuous with the blastodisc, takes no active part in morphogenesis, in the sense that it is extra-cellular so far as the dividing cells of the blastodisc are concerned. The formation of the blastodisc, as related to the contractile tension of the superficial gel layer of the egg, has been described by Lewis and Roosen-Runge (1942, 1943) for *Brachydanio rerio*, the zebra-fish.

The blastodisc alone cleaves, and forms the embryo. When cleavage has proceeded for an appropriate period, the blastoderm flattens down on the yolk, and gradually expands to cover it. Its expansion has been described by Lewis (1943) in *Brachydanio* as related to contraction of the superficial gel layer of the yolk; the cells of the blastoderm at this stage are embedded in a semi-gel

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matrix covered externally with a gel layer continuous with that of the yolk.

In *Fundulus*, when the process of expansion gets under way and gastrulation begins, the blastoderm thins out excentrically, in such a way that the thinner central area, the extra-embryonic epithelium, is surrounded by a thicker rim, the germ-ring (*Randring, bord d'enveloppement*). At one region on the periphery the thickening of the rim extends further centrally in the blastoderm than elsewhere. This region, which will form the embryo, is called the embryonic shield; its anteroposterior axis will become the longitudinal axis of the embryo.

As the blastoderm gradually expands to cover the yolk, the cells which are to form the roof of the archenteron move in below the surface at its posterior lip, and the embryonic primordium increases in length. In *Fundulus*, where the yolk is smaller in proportion to the blastoderm than is the case for *Salmo*, very little differentiation has occurred in the shield at the time when the yolk is completely covered by the blastoderm; the solid keel which sinks down to form the central nervous system is usually the only visible organ-rudiment (Oppenheimer, 1937). In the larger-yolked *Salmo*, the nervous system is more highly differentiated, and eyes, otic vesicles and somites are well demarcated by the time the yolk is covered (Pasteels, 1936).

Relationships of the yolk to morphogenesis

The dispensibility of the yolk for normal morphogenesis was suggested first by Morgan (1893), who reported that "the yolk may be removed from the egg of *Fundulus* at almost any stage of development and the embryo still forms" (p. 809). Morgan reported the formation of "perfect" embryos when half or two-thirds of the yolk was removed during early cleavage stages, but considered there to be "a point of reduction however beyond which it is impossible to go; for when the yolk is reduced to about the same size as the protoplasmic disc the latter (if not already segmented) does not divide; if previously in the two- or four-cell stage a few irregular divisions succeed but no embryo is produced" (pp. 809–810).

These observations were later extended by the demonstration (Oppenheimer, 1934b, 1936a) that the blastodiscs of *Fundulus* removed from the yolk during early cleavage stages could develop in modified Holtfreter's solution to form hyperblastulae comparable to those developed by Rand-zone-free portions of amphibian eggs. Those removed at the thirty-two cell stage and later could gastrulate and develop embryonic structures or even embryos. Confirmation of these results was obtained from the eggs of *Carassius auratus*, the goldfish, by Tung, Chang, and Tung (1945), who studied the development of latitudinally divided eggs and isolated blastodiscs in this form. Here in eggs divided latitudinally at the one- and two-cell stage, fragments containing the blastodisc but less than half the yolk formed hyperblastulae; fragments the same size derived from eggs divided at the four-cell stage formed embryos. Isolated blastodiscs in this form differentiated embryonic structures or embryos when removed from the yolk after the eight-cell stage. Devillers (1947) has stated that blastoderms of the small rapidly-developing eggs of *Esox lucius*, the pike, isolated at the blastula stage, develop embryonic structures when cultivated in triple-strength Holtfreter's solution.

Oppenheimer (1934b, 1936a) had considered the difference in reaction of the blastodiscs separated from the yolk during early and later cleavage stages as possibly explained by the fact that normally some substances necessary for the subsequent initiation of gastrulation pass into the cells from the periblast during the course of cleavage. Tung, Chang, and Tung (1945) considered their results to support this hypothesis. The fact that the passage of the hypothetical substances was completed at an earlier cleavage stage in *Carassius* may possibly be related to the fact that in this form the yolk is relatively smaller in proportion to the blastodisc than in *Fundulus*. To test this hypothesis, experimental evidence is required relative to the behavior of blastodiscs isolated from the more slowly developing larger-yolked teleost eggs. Devillers (1947) has cultivated the blastoderms of *Salmo fario* isolated at the blastula stage in triple-strength Holtfreter's solution, and has found that they differentiated only hyperblastulae, which suggests that the blastoderm of *Salmo* at this stage lacks some substance to enable it to complete differentiation. Since Luther (1936a) has shown, as will be discussed below, that isolated quarters of blastulae of *Salmo* can differentiate embryonic tissues after transplantation to the yolk-sac epithelium of older larvae, whatever substance is required by the blastula for differentiation must be able to be supplied to it from the yolk or

membranes of older as well as of young stages. In all cases where differentiation fails, however, in isolated blastoderms, it must be remembered that some unknown factors incident to the experimental treatment of the material may have suppressed whatever capacities for differentiation are inherent in the cells.

Aside from its relationship to the provision of the hypothetical substance or group of substances to the blastoderm, the significance of the yolk to development, from the mechanical and physiological side, must not be minimized. The embryos formed in the absence of the yolk in *Fundulus* lacked posterior trunk and tail structures, presumably as a result of altered mechanical relationships during gastrulation; the assumption was that the number of cells gastrulated and hence the length of the embryonic axis were limited by the extent of the base against which the lower-layer cells were involuted. In *Carassius*, however (Tung, Chang, and Tung, 1945), none of the embryos differentiated by isolated blastodiscs lacked trunk and tail structures; presumably here again the explanation of the discrepancy between the results in *Fundulus* and *Carassius* may be related to the smaller relative size of the yolk in the latter. It is not unreasonable to assume that the mechanical relationships of the yolk to the cells differ according to the relative size of yolk and blastodisc. Unfortunately, reports of comparable experiments on *Salmo* or other really large-yolked forms are lacking.

In *Fundulus*, too, the organs and tissues differentiated in the isolated blastoderms were found in abnormal topographical relationships to one another, presumably as a result of altered water-metabolism. Discussion of the significance of the yolk as an organ of metabolism is however out of the province of this review. Readers who demand a description of more direct visible manifestations of the great physiological activity of the yolk are referred to the extensive series of papers on its rhythmical contractions by Yamamoto (1931a, 1931b, 1933a, 1933b, 1934, 1936a, 1936b, 1938a, 1938b, 1938c).

Prospective significance of the cleavage planes and cleavage blastomeres

Important though the yolk may be for the normally developing embryo, it is not our primary concern here, and the ensuing discussions will confine themselves to the analysis of factors presumably resident in the blastoderm itself. The early cleavage planes follow a neat geometrical pattern through the sixteen- and sometimes the thirty-two-cell stage. A few of the early workers on teleosts (Agassiz and Whitman, 1884; von Kowalewski, 1886) presumed to have demonstrated that the first cleavage plane becomes the longitudinal axis of the embryo, but Clapp (1891), working on *Batrachus*, the toadfish, Morgan (1893), working on *Ctenolabrus*, the cunner, and *Serranus*, the sea-bass, and Oppenheimer (1935a, 1936d), working with vital stains on the blastodisc of *Fundulus*, have found no constant relationship between the embryonic axis and the position of the planes of cleavage. The latter two authors, however, noted some tendency for the longitudinal axis of the embryo to coincide in position with the second cleavage plane.

Vital staining experiments performed on the cleaving blastodisc (Oppenheimer, 1936d) have demonstrated, too, that in *Fundulus* there is no constant contribution of specific blastomeres to the visibly distinct parts of the gastrula: sometimes four blastomeres of the sixteen-cell stage, and sometimes only two, contribute to the formation of the early embryonic shield. This lack of constancy of relationship between particular cells of the cleaving blastoderm and specific parts of the embryo is of course strictly compatible with the fact that the development of the teleost is of the inductive type. There is some evidence, however, to be discussed below, which suggests that in some teleosteans the early blastomeres are not all necessarily equivalent to one another in terms of potency for differentiation.

Cell-movements during gastrulation

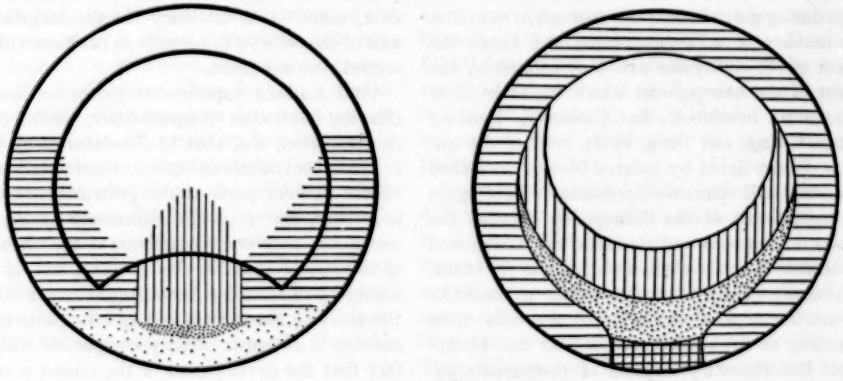
The course of the cell-movements during gastrulation has been plotted by vital staining methods for *Salmo* (Pasteels, 1933, 1934a, 1936) and for *Fundulus* (Oppenheimer, 1935a, 1935b, 1936d). The validity of the doctrine of concrescence, first suggested by His (1876), and later modified by Kopsch (1904), for the development of the teleost, had been already shadowed by doubt as a result of the experiments of Morgan (1893, 1895) on *Fundulus*, and indeed by the experimental results of Kopsch (1896, 1904) himself, although he did not so interpret them. As a matter of fact, deficiencies in the mesoderm of embryos in which the germ-ring or Randring had been prevented from contributing to the embryonic primordium (Morgan,

1895; Kopsch, 1904) clearly indicated that the periphery of the blastoderm furnishes mesoderm for the embryo. It remained, nevertheless, for the vital staining experiments to analyze more precisely the paths followed by these cells, and others, during gastrulation in the fish.

The maps that have been constructed for the teleosts lack the exactitude characteristic of those for the amphibian. The cells of the teleost blastoderm lack the pigment which in the amphibian is responsible for the maintenance of vivid color within the stained areas, and the stains fade more rapidly in the teleost than in the amphibian. The extreme tenuousness of some of the cell-layers in the fish is a disadvantage in following the fate of stained areas. In these forms, furthermore, the stains have been followed only in the living blastoderm, and have been studied neither in sections nor dissections.

In spite of these difficulties, imposed in part by the limitations of the staining techniques so far elaborated for the fish egg, the nature of the cell-movements and the localization of the major areas has been worked out adequately to provide a reasonably sound basis for the operative experiments performed on the eggs of this group. If the exact limits of the areas of the blastoderm are less precisely demarcated than is the case for the amphibian, yet the general relationships of the areas one to another are sufficiently clearly established to demonstrate both the fundamental similarity of the pattern in the two types of fish studied to that of the amphibian, and the divergence of the two teleostean patterns from each other in some interesting details (Figs. 1, 2).

The prospective endoderm, obviously, in the teleost, is contained in the cellular blastoderm, not in the yolky portion of the egg. In both *Salmo* and *Fundulus* it seems to be located in a crescent at the pole of the blastoderm which is to undergo involution at gastrulation; in neither form have its exact limits been ascertained to the same degree of accuracy as have those of certain other areas of the blastoderm. Pasteels figures the approximate extent of the area in one of his early maps for *Salmo* (1934a) but has omitted the territory entirely from the definitive chart (1936).



FIGS. 1 and 2. MAPS SHOWING POSITION OF AREAS FOR PROSPECTIVE TISSUES IN THE EARLY GASTRULAE OF FUNDULUS (1) AND SALMO (2)

Endoderm, light stipple; notochord, heavy stipple; prechordal plate, cross-hatching; nervous system, vertical shading; mesoderm, horizontal shading. Fig. 1 after Oppenheimer, 1936d; Fig. 2 simplified after Pasteels, 1936. Drawn by Rosemary Gilmartin.

Immediately anterior to the endoderm area in both forms (considering the lip of the embryonic region to be posterior) is a crescent for the prospective chorda; its wings have been demonstrated to extend relatively further laterally in *Salmo* than in *Fundulus*. The prospective mesoderm in both forms has been found to be located laterally and peripherally in the blastoderm with reference to the prospective chorda and endoderm.

The areas for the prospective nervous system, in both of these teleost forms, are found in the same relative position, just anterior to the chorda-mesoderm crescent, but the shape of the area

differs in the two forms: in *Salmo*, as in the amphibian, it is a wide crescent; in *Fundulus* it seems to be compressed into a much narrower area. The remainder of the blastoderm consists largely of prospective epidermis.

Pasteels (1936) expresses himself as certain, so far as the map of *Salmo* is concerned, of the accuracy of representation of the anterior limits of the prospective nervous system area and of the relationships of its cephalic and trunk portions, of the lateral limits of the median part of the territory for prospective chorda, of the levels where the horns of the chordal crescent terminate, where the lateral mesoderm begins. He admits, however, that the exact width of the areas has not been definitely proved. In *Fundulus*, neither the exact size nor shape of the areas is known for certainty. But in both forms the general geographical relationships of the territories to one another may be considered as reasonably well established. It would be well for investigators to remember, however, that exactness in recognition of borders may prove of as great significance to embryological as to political cartographers, and the desirability of establishing such borders on a sound basis by the use of improved technical methods cannot be overemphasized.

The maps which show the positions of the prospective areas at the time gastrulation begins, however, are of interest only in so far as they designate the points of departure of the cells, and an appreciation of their true significance demands a detailed knowledge of the paths taken by the cells during gastrulation in order to attain their destinations. The movements undertaken by the cells during gastrulation have been plotted for *Salmo* (Pasteels, 1933, 1934a, 1936) and for *Fundulus* (Oppenheimer, 1935a, 1936d). Pasteels (1934b, 1936), by performing mitotic counts, has confirmed for *Salmo* what is known for many other vertebrate forms, namely, that the activities during gastrulation are limited to the rearrangements of cells, and he has excluded their differential multiplication as a causal factor in this phase of morphogenesis. These rearrangements consist, in the main, of movements of involution, "extension," and convergence; for specific details the reader is referred to the original communications. The significance of intracellular activities in which the cells may indulge during the performance of these movements remains unfortunately largely uninvestigated.

ANALYSIS OF DEVELOPMENTAL POTENCIES

Regulation during cleavage stages

The fish egg has long been known to be highly regulable at cleavage stages. Morgan (1893, 1895), Lewis (1912a), Hoadley (1928) and Nicholas (Nicholas and Oppenheimer, 1942) working on *Fundulus*, and Tung and Tung (1943) on *Carassius* have all demonstrated that after removal of part of the blastodisc at cleavage stages, the remainder can form an embryo reduced in size but apparently normal in structure.

Hoadley (1928) removed different combinations of blastomeres at the four-cell stage, and Nicholas (Nicholas and Oppenheimer, 1942) demonstrated a high percentage of embryo-formation in eggs from which one of the first two blastomeres had been removed at random (embryo-formation in sixty-five out of seventy-two cases). These authors have therefore suggested that it is indicated for *Fundulus* that all parts of the early cleavage blastodisc are totipotent, although admittedly their experiments do not provide incontrovertible proof of this.

Tung and Tung (1943), however, in their studies on *Carassius*, apparently do not concur in this interpretation. They found that when one of the first two blastomeres was removed in this form, normal embryos were formed in more than half the cases; in the remainder of their cases the blastoderm developed only abnormal embryos or vesicular structures. These authors assume, in contrast to the American workers, that very early in development, in *Carassius* at least, totipotency is limited to a particular part of the blastoderm, the future embryonic region of it; and they assume that it is into this portion of the blastoderm that the substances postulated as necessary for gastrulation migrate from the periblast during the early cleavage stages, as previously described.

Clearly the discrepancy in the interpretations of the results on the cleavage stages can be resolved only when an experimental method is available which will allow maintenance of both of the two-cell stage blastomeres after separation. Tung and Tung (1943) have apparently been able to perform this experiment successfully in *Carassius* by dividing the whole egg into two portions along the first or second cleavage planes. Their 1943 paper has not been available to the author and seems not to have reached this country at the present writing; the paper by Tung, Chang, and Tung (1945),

which describes the fact that such experiments were performed, fails to make clear their results and whether they actually substantiated the interpretation given to the results of removing blastomeres by deletion.

It remains to be seen, furthermore, whether more critical experiments on *Fundulus* will confirm the suspicions of the investigators who have begun the studies on this form, thus establishing basic differences between *Fundulus* and *Carassius* in this respect. To the best of the present reviewer's knowledge, there is no report in the literature of the result of removing early blastomeres from the egg of *Salmo;* however, certain experiments, to be taken up in the next section, which have been performed on the blastula of this form tend to support the suggestion that all parts of its blastoderm are totipotent before gastrulation.

Regulation during the blastula stage

There have apparently been reported no deletion experiments on blastula stages of *Carassius.* Lewis (1912a), Hoadley (1928), Oppenheimer (1934b), and Nicholas (Nicholas and Oppenheimer, 1942) have performed defect-experiments on the blastula of *Fundulus* which have been followed by complete regulation, but these experiments are open to the same criticism as the defect-experiments on cleavage stages in *Fundulus:* there is no way of ascertaining what parts of the blastula have been removed.

The totipotency of the various parts of the pregastrular blastoderm has been demonstrated for *Salmo*, however, both by isolation- and by recombination-experiments. The isolation-experiments were performed by Luther (1936a), who used Mangold's (1931) method of grafting material from young blastoderms to the yolk-sac epithelium of older *Salmo* embryos. Mangold had made successful, but not particularly instructive, grafts of material removed from the blastoderm as early as the morula stage.

Luther's isolation-experiments (1936a) consisted of dividing the blastoderm into four quarters and implanting each quarter on the yolk-sac epithelium separately. All four quarters of a single blastoderm, extra-embryonic as well as embryonic (and these may be distinguished from each other before gastrulation in *Salmo* by virtue of the excentric position of the blastocoele), were found capable of differentiating nervous tissue, chorda, segmented musculature, gut tube, pronephric tubules, and auditory vesicles; in most cases the differentiated tissues were not found in their usual topographical relationships to one another, but were in apparently haphazard arrangement in the grafts. The fact that four quarters of a single blastoderm could differentiate such varieties of tissues suggests very strongly that all sectors of the pregastrular blastoderm are totipotent in *Salmo.*

This is borne out by Luther's (1937a) series of transplantation-experiments on the blastula in which two extra-embryonic halves of blastulae were combined by grafting. This experiment was performed in nine cases; for controls, a parallel series of experiments was run in which two embryonic halves of blastulae were grafted together. In the control series, two embryos were formed by the conjoined half-blastoderms in each case, thus justifying the investigator in his belief that he could distinguish, before gastrulation, between the embryonic and extra-embryonic halves of the blastoderm. Embryonic primordia were differentiated in eight of the nine cases where the extra-embryonic halves were combined. The anterior portion of the head was generally atypical, and in two cases duplicities developed; seven of the eight embryos, however, contained chorda, in spite of the fact that none of the prospective chorda area is included in the extra-embryonic half of the blasoderm. It seems perfectly clear from these results that the portions of the blastoderm which do not include the prospective embryonic region are thoroughly capable of differentiating an embryonic primordium. The blastoderm of *Salmo*, therefore, must differ from that of *Carassius* with respect to the time at which totipotency becomes limited to one pole of the blastoderm.

Regulation in the prospective embryonic region of the gastrula; induction

The fact that the embryonic shield of the gastrula is to a certain extent regulable has been made evident as a result of defect-experiments performed on *Fundulus* embryos by Sumner (1904), Lewis (1912b), Hoadley (1928), Oppenheimer (1936b), and Nicholas (Nicholas and Oppenheimer, 1942). Luther (1935, 1937a) has performed defect-experiments on *Salmo* which show that embryonic development occurs only rarely after removal of a large sector including the embryonic region, but more frequently after removal of a small sector; his experiments, and further modifications of them,

will be discussed in greater detail below in another connection.

All of these experimental results, together with the evidence from teratology which shows that twinning in teleosts first manifests itself at the time of gastrulation (Schmitt, 1902; cf. also Lereboullet, 1863), present strong presumptive evidence that differentiation is determined during gastrulation in the teleost, and hence that the development of the teleost is regulated by an "organizer" comparable to that of the amphibian. Since, however, these analyses are none of them adequate to demonstrate conclusively the specific factors responsible for developmental control, further discussion of them will be omitted here.

It is perhaps superfluous to mention that the requisite experiments to demonstrate the factors regulating the establishment of the embryonic axis must be performed not by deletion- but by transplantation-experiments. The demonstration that the lip of the embryogenic area of the teleost blastoderm operates as an "organizer" comparable to that of the dorsal lip of the amphibian blastopore has been demonstrated by transplantation of part of the lip region in *Perca* and *Fundulus* (Oppenheimer, 1934a, 1934b, 1936b) and by transplantation of part of the archenteron roof in *Salmo* (Luther, 1935).

In the experiments on *Perca* and *Fundulus*, portions of the dorsal lip region were implanted sometimes into the embryonic shield, sometimes onto the supposedly more indifferent yolk-sac epithelium of gastrulae approximately the same age as the donor, the graft, in most cases, inducing a secondary embryo. The fact that the secondary embryos were formed by the hosts as a result of inductive interaction with the grafts, and not by self-differentiation of the grafts themselves, was demonstrated in cases in which host and graft embryos had been previously stained with vital dyes of different colors (Nile blue sulphate and neutral red). Secondary embryos of varying degrees of completeness were obtained.

The experiments on *Salmo* have analyzed more precisely than those on *Fundulus* the mechanisms involved in the induction of the embryonic axis. In this form, already invaginated archenteron roof, transposed from the embryonic region to the opposite extra-embryonic region of the blastoderm, was shown to be able to induce the formation of a secondary embryo (Luther, 1935). In addition, double embryos, each regulated to form a whole, were produced artificially in this form, as previously in the amphibian, by splitting the "organization-center" into two parts and interchanging its left and right halves (Luther, 1935).

Still further similarities between the inductive processes in fishes and amphibians were brought out by the demonstration that in *Salmo*, as in *Triton*, nervous tissue from older embryos was capable of inducing a rudimentary embryonic primordium consisting of nerve tissue, mesoderm, and chorda; the inductive effect of boiled archenteron roof was also described (Luther, 1935). As further demonstration of the fact that in the fish, as well as in the amphibian, the inductive process is non-specific in nature, liver of *Triton taeniatus* was found capable of producing a rudimentary induction after implantation into the blastoderm of *Salmo* (Luther, 1935). An even more vivid demonstration of the fundamentally general quality of induction was that in which living fish "organizer," taken from the blastoderm of *Danio rerio*, the zebra-fish, self-differentiated chorda and somites and induced the formation of a half medulla oblongata and an auditory vesicle in a *Triturus torosus* host (Oppenheimer, 1936c). The inductive effect demonstrated at the level of interaction between living fish "organizer" on one hand and living reacting cells of the amphibian on the other, emphasizes as strongly as any experiment involving the use of dead material or synthetic chemical substances the basically non-specific character of the inductive processes.

The more detailed mechanisms of "organizer" action have been quite precisely analyzed for *Salmo*. For instance, the significance of the Unterlage for the differentiation of the overlying tissues has been demonstrated in *Salmo* by the repetition of one of the classical experiments borrowed from Spemann's amphibian programme, namely, by the rotation through 180° of a portion of prospective ectoderm, in such a way that prospective neural material is exchanged in position with prospective epidermis (Luther, 1936b). The results were the expected ones, and the prospective nervous system tissue differentiated only epidermis in the absence of influence from the archenteron roof, while the prospective epidermis, under the influence of the Unterlage, differentiated normal brain and sense organs. It has also been demonstrated that material from the prospective neural or epidermal areas, when grafted to the yolk-sac in the absence of

accompanying lower layer cells, fail to differentiate nervous structures (Luther, 1936b).

Oppenheimer (1936a) had described, in some of the isolated blastoderms of *Fundulus*, the abortive differentiation of nervous system in the absence of differentiated chorda-mesoderm, and suggested at that time that perhaps the *Fundulus* blastoderm has greater powers of self-differentiation than the amphibian embryo. These findings were subsequently confirmed by Tung and Tung (1943) and Tung, Chang, and Tung (1945) for *Carassius*. In view of Holtfreter's recent contributions (1944, 1945), showing that such differentiation can occur under certain conditions in the amphibian too, there now seems less discrepancy in this respect between the fish and the amphibian than there seemed ten years ago. The present author cannot speak for the condition of the *Carassius* material, and the Chinese authors have not done so, but in the isolated blastoderms of *Fundulus* the cells were in abnormal physiological condition, and some of them were cytolyzed; presumably the abortive neural differentiation was related to this phenomenon in the fish, as it is now known to be for the amphibian.

Still further details of similarity between the inductive processes in fish and amphibian emerge when the properties of "regional determination" are explored in the teleost. In the experiments involving the transplantation of the dorsal lip in *Fundulus* it was observed that when the grafts were implanted into the embryonic shield, corresponding embryonic structures were usually found at approximately the same antero-posterior level in both primary and induced embryos (Oppenheimer, 1934b, 1936b). When the grafts were implanted into extra-embryonic regions, in contrast, the induced embryos bore no constant relation to the host embryo. It was suspected that in these latter cases the nature of the structures induced was related to factors inherent in the grafted cells.

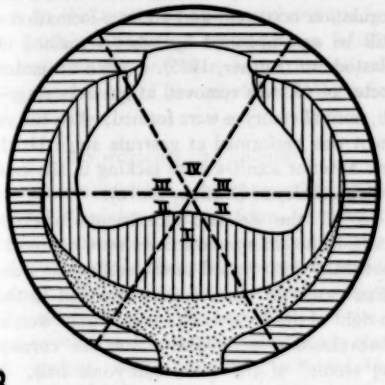
Indirect evidence for the fact that the "organizer" in *Fundulus*, although in itself to a certain degree regulable, possesses properties responsible for "regional determination," is provided by an anomalous set of twin embryos, in which one individual lay immediately anterior to the other. The anterior embryo had an approximately normal head, a short trunk and an abnormal tail; the posterior embryo was anencephalic, had only a narrow trunk, and an approximately normal tail (Oppenheimer, 1946).

The fact that qualities indeed exist within groups of inducing cells, which are comparable to the factors responsible for "regional determination" in the amphibian, has been definitively demonstrated by Eakin (1939) for *Salmo*. This investigator has divided the invaginated archenteron roof of middle gastrulae of *Salmo* into an anterior, a middle, and a posterior portion, wrapped each in a tube consisting of the extra-embryonic half of a late gastrula, and implanted the compound graft to the yolk-sac epithelium of an older *Salmo* embryo. For a control, in each case, a graft of the extra-embryonic half of a late gastrula was implanted in the same host as the composite graft. The control pieces differentiated only epidermis. When the anterior portion of the archenteron roof was implanted together with indifferent ectoderm, it exhibited little or no power of induction, and differentiated for the most part digestive tube. When the middle portion of the roof was transplanted, it differentiated notochord, somites, gut, and pronephric ducts, and induced the accompanying ectoderm to differentiate neural structures, primarily brain-like in character, and auditory vesicles. The posterior portion of the roof, when grafted, also differentiated chorda, somites, gut, and mesonephric duct; in this case, however, the neural structures induced from the accompanying ectoderm were spinal rather than cranial in character. The three portions of the archenteric roof are thus demonstrated to be essentially similar to the prechordal plate, the "head organizer," and the "trunk organizer," respectively, of the amphibian gastrula.

Organization of the blastoderm as a whole during gastrulation

The experiments which have been outlined above present conclusive evidence that the factors responsible for the establishment of the embryonic axis are strikingly similar in fish and amphibian. For the fish, as well as for the amphibian, the essential nature of the organizing forces operative in the integration of the developmental processes remains to be elucidated by methods not yet at our command. It is possible, however, that in the teleosts, where the formation of the embryo is limited in some cases to a relatively small portion of the blastoderm, there are demonstrable integrative activities at play whose role is the coordination of the various parts of the blastoderm. There is some experimental evidence available, both for *Salmo*

and for ***Fundulus***, which suggests the existence of such activities, and which suggests, indeed, that their nature is not identical in the two forms.



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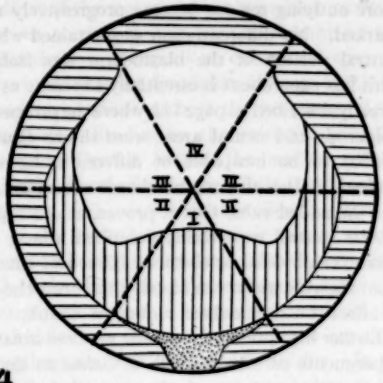

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FIGS. 3 and 4. SECTORS OF THE BLASTODERM OF THE EARLIER (3) AND LATER (4) GASTRULAE OF SALMO ISOLATED ON THE YOLK-SAC EPITHELIUM

Endoderm, stippled; nervous system, vertical shading; mesoderm, horizontal shading. See text and Table 1 for discussion. After Luther, 1936a. Drawn by Rosemary Gilmartin.

TABLE 1

Frequency of differentiation of portions of Salmo blastoderm isolated on yolk-sac epithelium

(after Luther, 1936a)

	GASTRULA Ia	GASTRULA Ib	GASTRULA IIa	GASTRULA IIb	NEURULA
Median embryonic sector (I, Figs. 3 and 4).	97%				
Lateral embryonic portions (II, Figs. 3 and 4).		84%		66%	69%
Lateral extra-embryonic portions (III, Figs. 3 and 4).	42%	10%	0	4%	
Median extra-embryonic sector (IV, Figs. 3 and 4).	20%	0	4%	12%	

Experiments on Salmo

The relationships to each other of the various parts which constitute the blastoderm as a whole have been studied in various ways in *Salmo*. One of the most fruitful attacks on this problem has been by the execution on the gastrula of the experiment already described for the blastula of *Salmo*, namely, the isolation of its separated sectors on the yolk-sac epithelium of older embryos (Luther, 1936a). In this series of experiments, the blastoderm was generally divided into six equal sectors (Figs. 3, 4): a median embryonic sector (I), adjacent to it on either side a lateral embryonic portion (II), a median extra-embryonic sector (IV), and two lateral extra-embryonic portions (III). Here, in contrast to the results for the blastula, not all parts of the blastoderm proved to be equivalent, and the various sectors differed from one another in their accomplishment, as illustrated in Table 1. At all the stages investigated, the potency for differentiation, as indicated by the percentage of grafts differentiating histologically diagnosable tissues, was highest in the embryonic sector and

lowest in the portions of the blastoderm most remote from it, diminishing gradually around the blastoderm; during the course of gastrulation the differences between the median embryonic and the more outlying regions become progressively more marked. No differentiation was attained when a central portion of the blastoderm was isolated. This last experiment is essentially the same as that already described on page 111, where the prospective epidermis and neural areas were shown (Luther, 1936b) to be incapable of differentiating when grafted in the absence of chorda-mesoderm. It has the added value that it proves, as did Eakin's (1939) control experiment described above, that whatever physical or chemical influences emanate from the yolk-sac or the blood of the host, they fail to affect the graft cells as inductive stimuli.

Luther interpreted the results of these isolation-experiments on the gastrula of *Salmo* as demonstrating the existence of what he called a physiological gradient field. He postulated that the potency for differentiation in any particular sector was related to the state of physiological activity (Aktivitätszustand) of its constituent cells, which in turn varies according to the position of the cells with respect to the whole and according to their age. It is highest in the embryonic sector and lowest in the extra-embryonic; in the lateral embryonic and in the extra-embryonic regions, it diminishes progressively during the course of gastrulation.

Luther (1937a) performed other experiments, in addition, by both deletion- and transplantation-methods, which he considered to strengthen the validity of this interpretation. The deletion-experiments involved differing amounts of material. When a sector of more than 90° was removed from the embryonic area, no embryo was formed; in the absence of embryo-formation, however, the blastoderm still gradually expanded to cover the yolk (Luther, 1935, 1937a). There were exceptions to these statements furnished by several so-called "steckengebliebene" embryos, where overgrowth of the yolk failed to ensue after 90° portions including the embryonic area were deleted. In these cases, in contrast to the cases in which epiboly occurred, an embryo was formed, and indeed an embryo in which regulation was so complete that even the heads were symmetrical. For some reason, apparently, the regulability of the "steckengebliebene" embryos is far higher than in the other cases. The author states that this is "a fact which can also be observed in yolk-sac transplantations" (Luther, 1937a, p. 410), but he gives no specific data concerning the latter. When a 70° sector was removed from the embryonic area, regulation occurred, and embryo-formation could still be accomplished by what remained of the blastoderm (Luther, 1935). When an embryonic sector of 45° was removed at gastrula stage Ia or Ib, normal embryos were formed; when the experiment was performed at gastrula stage II, chorda and anterior somites were lacking in the embryos which developed (Luther, 1937a).

In all the deletion-experiments already described, the embryonic sectors were removed symmetrically with regard to the embryonic axis. In other cases, 45° sectors were removed to the left or right of the embryonic axis; the gaps were sometimes closed by being filled in with the "corresponding sector" of the extra-embryonic half. These blastoderms, when the defects were made to young gastrulae, regulated to form embryos that were essentially normal, though sometimes slightly asymmetrical. When comparable experiments were performed on older gastrulae, less regulation was evident.

These results could all be explained on the basis of the postulated physiological gradient field. When the material characterized by the highest state of activity is removed from the embryonic area, the adjacent portions, which are then highest, are able to take over the task of organizing the formation of an embryo. A sufficiently high state, however, is lacking in the gastrula in cells located more than 45° to either side of the embryonic axis; hence the failure of regulation after deletion of the 90° sectors. The regulability was greater when the experiments were performed on earlier gastrulae than when on later stages because of the gradual diminution during the course of gastrulation of the state of physiological activity in the cells at the sides of the embryonic area.

A final series of experiments was performed (Luther, 1937a) in which the investigator removed various amounts of the embryonic sector, substituting for it extra-embryonic material in varying positions, medially or laterally with respect to the embryonic axis. When a 90° sector is removed and the gap filled in by extra-embryonic material, the expectation is that no embryo will be formed, because there is nowhere a sufficiently high state of activity remaining to warrant the establishment of an embryonic axis. When a sector smaller than

90° is replaced by extra-embryonic material, the expectation is that either one or two embryos will be formed, depending on whether the graft is implanted symmetrically or asymmetrically with respect to the center of the postulated gradient field. Luther interpreted his results as fulfilling these expectations, and thus as further substantiating the notion of the physiological gradient field.

Experiments on Fundulus

No such gradient has been observed to exist in the egg of *Fundulus*. In this form, however, the experiments designed to test the potencies of the outlying parts of the blastoderm were performed in a slightly different way than in *Salmo* (Oppenheimer, 1938) and may not have been sufficiently critical to warrant drawing conclusions from them. Small portions of the germ-ring, removed from regions 90° or 180° away from the embryonic axis, were grafted into the embryonic shield or on the extra-embryonic membrane of an embryo the same age as the donor. Such grafts implanted on the extra-embryonic membrane failed in all except one case to differentiate any structures except epidermis, blood cells, and chromatophores, no matter what was the age of the donor embryo and irrespective of the source of origin of the graft. The same was true for grafts that became located in the pericardium. In contrast, grafts from the 90° and 180° germ-ring of gastrulae of various ages, implanted into the shield, differentiated without exception, provided their cells were incorporated below the epidermis. The nature of the structures differentiated bore no relationship to the source of the grafts; head, trunk, and tail-structures were formed in grafts from both 90° and 180° regions of the germ-ring. In some cases, grafts formed structures characteristic neither of the region of the host to which they were transplanted nor of the region of the embryo for which the grafted cells were originally destined: that is, 180° germ-ring could differentiate pronephros when implanted into the brain-region of the host.

If the accomplishments of these grafted cells represent a valid expression of their inherent potencies, it can be inferred that there is no gradation of potencies around the germ-ring of the *Fundulus* blastoderm, and that what potencies the cells of the germ-ring possess for differentiation are expressed only after the interaction of these cells with those of the embryonic shield. The possibility cannot be neglected, however, that these experimental results are deceptive, the lack of differentiation of the grafts on the yolk-sac perhaps resulting from some trauma incidental to the handling of the materials. It is perhaps relevant, however, to note that in working out the pattern of distribution of regions of differential susceptibility in developing *Fundulus*, Hyman (1921) reported no gradient around the periphery of the blastoderm. Studies on the oxidation-reduction pattern in *Oryzias latipes*, the medaka (Child, 1943), and *Brachydanio rerio* (Child, 1945) are not conclusive with respect to a gradient around the rim of the blastoderm, but their results are not incompatible with the existence of such a gradient.

The behavior of the extra-embryonic germ-ring, isolated with respect to the embryonic shield, has been studied in a different fashion in the egg of the tropical cyprinodont *Epiplatys fasciolatus*. In this form, the whole egg can be cut into halves at late gastrula stages, one containing the whole embryonic shield, the other containing the part of the germ-ring originally most remote from the shield. The latter group of isolates exhibit a most striking behavior: the germ-ring cells form tail-like structures similar in shape to the tail of the normal embryo. When these structures are studied in section, they are found not to have undergone histogenesis, with the exception of occasional differentiation of chromatophores or blood cells. On the other hand, if the tail-bud region is isolated from an *Epiplatys* embryo at the early somite stages, it undergoes normal histogenesis of nerve cord, chorda, and somites.

Possibly, then, in *Epiplatys* as well as in *Fundulus*, some interaction between the cells of 180° germ-ring and the embryonic shield is required if these germ-ring cells are to undergo histogenesis, though this interaction is not necessary if the cells are to produce tail form. If these experiments are open to the same criticism as was voiced above concerning the lack of differentiation of transplanted germ-ring, namely, that some unknown factors incident to the handling of the material may have suppressed the processes of histogenesis, they are still interesting in that they demonstrate that the processes responsible for the differentiation of form are experimentally separable from those responsible for histological differentiation.

If the interpretations of the experimental results outlined are valid, it is apparent, from a comparison of the results on *Salmo* and *Fundulus*, that the

nature of the forces responsible for integrating the parts into the whole must differ in these two types of blastoderm. The dynamic relationships between the embryonic sector and the parts contiguous to it, where the latter possess powers of self-differentiation determined by an inherent gradient, may be presumed to differ qualitatively from such relationships in a blastoderm where the parts adjacent to the embryonic area fail to differentiate when isolated. While these conditions provide not the slightest hint of the specific nature of the forces operating, the fact that clear-cut differences occur suggests that this may be extremely favorable material indeed for an analysis of such agents.

SUMMARY

In conclusion, the principal generalizations to be emphasized are those which are readily apparent from perusal of the described experimental results.

Some of the relationships between yolk and blastoderm have been briefly described. The teleost egg is characterized by a relatively large fluid yolk surmounted by a blastodisc; the latter alone cleaves and forms the embryo. In *Fundulus* and *Carassius*, blastoderms separated from the yolk at later cleavage stages can differentiate embryos and embryonic structures, while those separated at earlier stages differentiate only hyperblastulae; the critical stage differs in the two forms. It has been suggested as a possible explanation of these phenomena that substances necessary for the subsequent initiation of gastrulation may pass into the cells from the periblast during the course of cleavage. Other factors, however, may be involved: in the case of *Salmo*, blastoderms isolated at the blastula stage in triple-strength Holtfreter's solution differentiate only hyperblastulae, while parts of the blastula transplanted to the yolk-sac epithelium of older *Salmo* larvae differentiate embryonic tissues.

The maps of the movements followed by the cells during the course of gastrulation in the teleosts are basically comparable to those constructed for the amphibian; such differences as are apparent may be due to the differing yolk relationships in the two groups. Minor variations in the patterns of movement distinguish the gastrulation of *Salmo*, a relatively large-yolked teleost, from that of *Fundulus*, which has a smaller yolk.

During cleavage, blastula, and gastrula stages, the fundamental dynamics of development in the teleost are comparable to those operative in amphibian development, as evidenced by the nature of the regulatory processes which follow appropriate experimental manipulation.

After removal of part of the blastodisc at cleavage and blastula stages, the remainder can form an embryo reduced in size but apparently normal in structure. Whether all parts of the blastoderm are capable of such regulation is not yet demonstrated. Some workers believe that in *Carassius* totipotency is limited to a particular part of the blastoderm; in *Salmo*, however, at least in the blastula stage, all parts of a single blastoderm can differentiate a wide variety of embryonic structure.

Gastrulation in the teleost egg is regulated by factors similar to those active in amphibian development, as demonstrated by deletion- and transplantation-experiments performed on eggs of *Salmo* and *Fundulus*. Defects to the embryonic shield are regulated under certain conditions; the transplanted dorsal lip of the blastopore acts as an "organizer"; the roof of the archenteron induces over-lying cells to differentiate central nervous tissue, and exhibits qualities of "regional determination"; the non-specificity of the inductive reaction has been demonstrated in the teleost as well as the amphibian by the results of experiments in which implants other than living dorsal lip have effected inductions. The fate and effect of implants to the embryonic shield in *Fundulus* differ from those of grafts to the extra-embryonic region. The extra-embryonic region, whose cells may react independently of influences from the primary embryo, presents advantages as a site for experimentation which to date have been insufficiently exploited.

The organization of the blastoderm as a whole may differ, during gastrulation, in the embryos of *Salmo* and *Fundulus*. Isolation-, defect-, and transplantation-experiments on gastrulae of *Salmo* suggest the existence of a physiological gradient field in the blastoderm of this form. The potency for differentiation of any particular sector of the blastoderm is related, according to this concept, to the state of physiological activity of its constituent cells, which in turn varies according to the position of the cells with respect to the whole and according to their age. No such gradient has as yet been demonstrated to exist in the blastoderm of *Fundulus*. If, as seems apparent at this writing, the nature of the forces integrating the parts into the whole differs in these two types of teleost blastoderm, this may provide favorable material for future physiological analysis of such integrative agents.

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COMPARATIVE PHYSIOLOGY OF THE THYROID HORMONE

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INTRODUCTION

THE practical justification for comparative physiology resides in the fact that some animals provide far more accessible material for the solution of a particular problem than others." (Hogben, 1929). The important role of the thyroid gland in human physiology and pathology has been the starting point for a great amount of animal experimentation. In the course of this work great differences between species have become evident. The literature is scattered, however, and it is quite difficult to form a composite picture of the function of the thyroid in various species.

The thyroid, like the pituitary and the parathyroid gland, is exclusively confined to the vertebrates. Experimental work on the thyroid is therefore confined to vertebrates. However, the striking effects of thyroxin on vertebrates have given rise to the question whether this compound has any effect on lower forms. Therefore this review will include a summary of the work done on Invertebrates and Tunicates.

Some of the effects of thyroxin described in the following pages are elicited by the use of doses far exceeding the amounts of thyroid hormone elaborated by the animal's own gland. These effects, as for instance, the induced metamorphosis of the axolotl or the depigmentation of birds' feathers, are not to be considered as normal physiological effects of the thyroid hormone.

Due to the proximity of the thyroid and parathyroid, the parathyroid glands have been often intentionally or unintentionally removed together with the thyroid glands. In reviewing such experiments reference will be made to the effect of removal of the parathyroids.

INVERTEBRATES

Some reports can be found in the older literature on the effects of thyroid hormones on the division rate of protozoans. The results are equivocal. Most workers today will agree with Koller (1938) that too little attention has been paid in these papers to factors like nutrition or the purity of the strain of protozoa used to allow any definite conclusions.

In view of the dramatic effect of thyroid feeding on amphibian metamorphosis, the study of the possible effects of thyroid feeding on insect metamorphosis seemed to be of interest. The work on this problem has been comprehensively reviewed by Schneider (1939). He has criticized many of the experiments, because no attempt had been made to determine the influence of a planned series of concentrations of thyroid substance on an invertebrate organism. This criticism is justified; on the other hand, it should be borne in mind that the effect of thyroid on amphibian metamorphosis can be easily demonstrated, using any concentration of the hormone above the minimal dose necessary to stimulate metamorphosis.

The work on *Drosophila* may serve as an example for this line of research. Alpatov (1929) and Koller (1932) studied the influence of thyroid on the development of *Drosophila melanogaster*. Alpatov fed powdered hog thyroid mixed with yeast to *Drosophila* larvae. There was a slight but statistically significant increase in growth in the experimental larvae as compared to the controls, but no influence on the rate of metamorphosis, fecundity, or size. It is quite possible that the effects in Alpatov's experiments were due to a dietary factor rather than to a specific effect of the thyroid hormone. Koller raised *Drosophila* on a medium containing thyroxin and found no effect on the rate of metamorphosis, on fecundity, sex-ratio, size, or crossing over.

Romeis (1925) found that the enzymes of the hepato-pancreas of the crawfish, *Astacus fluviatilis*, destroy the thyroid hormone. In order to avoid destruction of the active principle in the intestinal

tract, it seemed of interest to study the effect of thyroxin applied parenterally. Thyroxin in slightly alkaline solution was injected into the larvae of the moth, *Lymantria dispar* (Fleischmann, 1929). The control larvae were injected with equal amounts of the slightly alkaline solvent. No effects were observed in the duration of the larval or pupal periods of the experimental insects, as compared with the controls. Thyroxin applied during the larval period had no influence on color or pattern of the wings of the moths. Romeis and von Dobkiewicz (1932) and Romeis and Wüst (1932) noted that injections of thyroxin into the pupae of butterflies had no effect on metamorphosis. The butterflies emerging from the pupae injected with thyroxin were indistinguishable from the controls. In some experiments the oxygen consumption of the pupae showed a marked rise after injection with thyroxin. However, this effect was not always reproducible. The species used by Romeis and his associates were *Papilio podalirius*, *Vanessa io*, and *Vanessa atlanta*.

In summary, it can be said that all efforts have failed to demonstrate an unequivocal effect of the thyroid hormone on invertebrates.

TUNICATES AND ACRANIATES

The endostyle organ found in the lowest chordate animals—Tunicata and Acrania—was long believed to be homologous to the vertebrate thyroid gland. The idea has been discarded more recently for morphological reasons (Hyman, 1942) and because of the fact that neither the endostyle of the tunicate *Perophora annectens* (Gorbman, 1941), nor that of the acraniate *Amphioxus* (Gorbman and Creaser, 1942) is capable of storing radioactive iodine.

The Tunicata undergo metamorphosis, and so it seemed of interest to examine the influence of endostylar tissue on amphibian metamorphosis. Spaul (1928) observed no influence on the metamorphosis of tadpoles through feeding them tunicate endostylar tissue. The endostyle of the ascidian *Ciona intestinalis* was used. These negative results are not surprising, in view of the modern concept that the endostyle of the Tunicata is neither analogous nor homologous to the thyroid of the vertebrates.

However, Weiss (1928) reported that mammalian thyroid tissue had a slightly accelerating influence on the metamorphosis of larvae of *Ciona intestinalis*. Tablets of commercial desiccated thyroid extract were added to the sea water in which the larvae were cultured. Increased resorption of the tail was observed in animals thus treated with thyroid hormone. These results were confirmed by Bradway (1936), who worked with a different species, *Clavelina huntsmani*. Both solutions of thyroid extracts and of inorganic iodine gave marked acceleration of metamorphosis. Solutions of pure thyroxin were, however, without any effect on the metamorphosis of this ascidian.

FISH

The homology of the endostyle of the Tunicata and Acrania to the vertebrate thyroid gland is questionable. Morphologists agree, however, that parts of the subpharyngeal gland or endostyle of ammocoetes larva develop into the thyroid gland of the adult lamprey. The thyroid gland of the adult lamprey shows the histologic structure characteristic of the thyroid gland common to all vertebrates (Hyman, 1942). A chemical functional analogy between the endostyle of the ammocoetes larva and vertebrate thyroid gland has been established by the studies of Gorbman and Creaser (1942). Iodine accumulation in specific cells of the endostyle of ammocoetes of the free-living lamprey *Entospenus lamottenii* was demonstrated by use of radioactive iodine. It seems significant that endostylar tissue actively removes inorganic iodine from its fluid environment and stores it intracellularly even before it has begun its definite differentiation into thyroid tissue. Conceivably such iodine metabolism might be concerned with the production of a thyroxin-like substance required for the physiological economy of a very long larval life. It is of the greatest interest that Gorbman and Evans (1941a) could show with the use of radioactive iodine that in another vertebrate with a free-living active larval life, the frog, iodine storage in the thyroid also begins very early, soon after completion of the embryonic tail-bud stage. In contrast, in the fetal rat initiation of storage of iodine is delayed until nearly the end of fetal life (Gorbman and Evans, 1941b).

Surgical thyroidectomy in fish has never been performed. However, chemical thyroidectomy (see below) has yielded interesting results. Goldsmith et al. (1944) immersed fish in solutions of the antithyroid drug, thiourea. This drug produces hypothyroidism through inhibition of the synthesis of the normal thyroid hormone (see below). A

hybrid strain involving *Platypoecilus maculatus* and *Xiphophorus helleri* was used. A marked inhibition of growth was noted in the fish exposed to thiourea. This was not due to inanition, since the animals accepted food as readily as did the untreated controls. A histological examination of the thyroid glands of the thiourea-treated animals, as compared with the controls, showed a very definite hyperplasia.

Fish are very insensitive to thyroxin. Administration of thyroid substances has no effect on either metamorphosis or metabolism in lampreys (Leach, 1946). Root and Etkin (1937) found that thyroxin injected through 4 to 5 days in doses of 10 mg. per kg. bodyweight had no effect on the oxygen consumption of the toadfish, *Opsanus tau*. However, the oxygen consumption of the same fish could be increased by injection of dinitrophenol in doses of about 7 mg. per kg. bodyweight. Smith and Everett (1943) confirmed the opinion that thyroid preparations fail to enhance oxygen consumption or somatic growth in the fish *Lebistes reticulatus*.

In the brook trout, *Salvelinus fontinalis*, hyperplasia of the thyroid has been studied by Marine and Lenhart (1910, 1911). This condition has to be considered as endemic goiter. Overfeeding and overcrowding are important factors associated with the development of thyroid hyperplasia. Prevention and cure is favored by adjusting the amount of food and the number of fish to the water supply and by the addition of iodine-containing substances to the water.

AMPHIBIANS

The discovery of a causal relationship between thyroid secretion and amphibian metamorphosis opened a new field of experimental biology. The earliest significant observation was that of Gudernatsch (1913), who found that a diet of thyroid administered to tadpoles of frogs led within a few days to the onset of metamorphosis. Thyroid administered at any age after the tadpole was capable of taking solid food had the same effect. The time at which the feeding began was of no importance to the result. If the treatment began early, the tadpoles fed on a thyroid diet underwent precocious metamorphosis with remarkable uniformity weeks before the controls fed on other tissues. The individuals of a thyroid-fed group in all cases transformed within about a day of one another. No such uniformity is seen in normal tadpoles nor in the control tadpoles fed by Gudernatsch on other tissues. Gudernatsch used the European species, *Rana esculenta* and *Rana temporaria*. Swingle (1918) confirmed these results on the American bullfrog, *Rana catesbeiana*. In a state of nature it requires two or three seasons for the tadpoles of this species to attain the adult condition, and the gonads contain ripe germ cells long before the onset of metamorphosis. Swingle fed desiccated mammalian thyroid to tadpoles of the bullfrog shortly after hatching. Within three weeks after hatching he had produced miniature frogs having all the bodily characteristics of the adult, except for larval gonads.

It is not our aim to review all papers confirming Gudernatsch's work, but to confine ourselves to work that sheds light on the mechanism of thyroid action or that contributes to comparative physiology.

It has been observed by a number of workers that in tadpoles the induction of metamorphosis by thyroid hormone is accompanied by a marked increase in oxygen uptake (Helff, 1926). Abelin and Scheinfinkel (1923) report an initial slight rise in total CO_2 production in tadpoles of *Rana esculenta* fed with thyroid tissue. The rise was followed by a decrease in CO_2 production during metamorphosis. On the basis of these and similar data, Hogben (1929) suggested "that the histogenetic incidents of metamorphosis are a consequence of the increased oxidative activity in the tissues." This problem has been reinvestigated more recently by Etkin (1934), who made careful measurements of the oxygen consumption of bull-frog tadpoles in relation to the various stages of normal metamorphosis. Etkin feels that there is at present no reason for ascribing any causative significance in metamorphosis to the influence of thyroid hormone on metabolism. The influence of increased oxidations on metamorphosis was studied with the use of dinitrophenol. This compound is known to enhance metabolism through the increase of tissue oxidations. Cutting and Tainter (1933) found no influence of this substance on the metamorphosis of the toad *Bufo halophilus*, using a wide range of concentrations up to toxic doses; and their negative results were confirmed by Fleischmann (1937). The obvious conclusion from these negative experiments is that the effect of thyroxin on metamorphosis is not the direct result of increased metabolism but is presumably an independent action.

It is possible, however, that the mechanism of action of thyroxin and of dinitrophenol on tissue oxidations is very different. The problem of chemical changes in the body of the amphibian undergoing spontaneous or induced metamorphosis should be reinvestigated. Observations like those of Haffner (1927), who found an increased content of lactic acid in the body of tadpoles treated with thyroxin, may prove valuable leads. In this connection it should be mentioned that Nagel (1927) suggests that the initial water loss after administering thyroid is a causative factor in inducing metamorphosis.

That the threshold for the morphogenetic action of the thyroid hormone is lowest in the epidermis of amphibians has been shown by Drzewicki (1924). He fed minute amounts of thyroid to larvae of the toad *Pelobates fuscus*. The epidermis was the only organ in which he could observe increased mitotic activity and differentiation. The other tissues did not respond to those small doses of thyroid.

Vitamin A has an inhibitory effect on amphibian metamorphosis induced by thyroxin. This has been shown on tadpoles (Eufinger and Gottlieb, 1933), and on larvae of *Amblystoma* and of *Salamandra maculosa* (Fleischmann and Kann, 1937). Nothing is known about the mechanism of this inhibitory effect.

Induced metamorphosis in amphibians is associated with a rise in metabolism. It has been shown by Helff (1923) that feeding of thyroid substance to tadpoles induces an increase in oxygen consumption, whereas the basal metabolic rate of frogs is insensitive to thyroid administration. This has been confirmed by Henschel and Steuber (1931), who found no influence of thyroxin on the metabolism of the frog *Rana esculenta*. Neither thyroidectomy nor subsequent administration of thyroid hormone had any effect on the basal metabolic rate. The authors emphasize the lack of toxic effects of thyroid on adult frogs. In mammals the sensitivity of basal metabolic rate to thyroid increases with age (*see below*). We have to bear in mind, however, that the main function of the thyroid in amphibians is concerned with metamorphosis, not with oxidations. That the sensitivity of amphibians to thyroxin is independent of chronological age, but is closely related to metamorphosis, is shown clearly by a comparison of the effects of thyroxin on sexually mature axolotls (Nagel, 1927) and on frogs (Henschel and Steuber, 1931). Only in the former is administration of thyroid associated with a drop in bodyweight.

The operative removal of the thyroid gland in amphibian embryos was first carried out on tadpoles of the frog *Rana pipiens* (Allen, 1917). No peculiarities attributable to the operation were detected until about three months after the thyroid anlage had been destroyed. At this time the controls started to undergo metamorphosis. The operated animals failed altogether to undergo metamorphosis, while growth continued and the gonads proceeded to develop. The brain and alimentary tract retained, along with the general external configuration, the larval characteristics. The vertebrae developed no spinous processes and remained unossified, though extensive calcification occurred. Deposition of lime salts went on, but the stimulus to the proliferation of odontoblasts was lacking.

The discovery that certain sulfur-containing drugs cause a marked hyperplasia of the thyroid gland (MacKenzie, MacKenzie, and McCollum, 1941; Richter and Clisby, 1942) led to the development of valuable tools for the study of thyroid physiology. The MacKenzies (1943) and Astwood et al. (1943) elucidated the mechanism of this action by showing that hyperplasia is prevented by administration of thyroid hormone and that it is associated with a fall in the basal metabolic rate. The effect on the basal metabolic rate can be neutralized by the administration of thyroid hormone concurrently with the antithyroid drug. In hypophysectomized animals the antithyroid drugs produce no hyperplasia of the thyroid gland. These facts prove that the antithyroid drugs act through inhibition of the formation of the thyroid hormone by the gland (Astwood et al., 1943). The thyroid hyperplasia is considered to be compensatory for the lack of synthesis of the thyroid hormone. It seems to be due to the stimulating action of the thyreotropic hormone elaborated by the pituitary gland.

Thiouracil, a derivative of thiourea, is used most commonly for experiments on the chronic inhibition of the formation of the thyroid hormone, or "chemical thyroidectomy," because of its low toxicity. The inhibition of amphibian metamorphosis by thiourea was first demonstrated by Gordon, Goldsmith, and Charipper (1943). Hughes and Astwood (1944) studied the inhibitory effect of thiouracil on tadpoles of the frog *Rana*

clamitans. Normal metamorphosis was inhibited by concentrations of 1:8000 to 1:2000. The rate of metamorphosis induced by thyroxin was not changed by the presence of thiouracil in a concentration of 1:2000. A measure of the effectiveness of thiouracil, in decreasing concentrations, as an inhibitor of the amphibian thyroid was provided by experiments on tadpoles injected with the thyrotrophic hormone of the pituitary. While tadpoles receiving thyrotrophic hormone of the pituitary were completely metamorphosed in 13 to 19 days, tadpoles living in a 1:2000 solution of thiouracil and receiving thyrotrophic hormone did not metamorphose. Since the action of thyroxin in inducing metamorphosis is not inhibited by thiouracil, these experiments offer evidence that the drug prevents the production of thyroid hormone. Gordon, Goldsmith, and Charipper (1945) in an extensive report on the effect of thiourea on the metamorphosis of *Rana pipiens* came to the same conclusion. They have very clearly demonstrated the reversibility of the thiourea effect. Development of frog larvae can be kept in complete abeyance by immersion in thiourea. Signs of resumed metamorphosis are displayed very early following discontinuation of treatment, provided the immersion is not continued for too long a time.

Slowikowska (1923) transplanted the thyroids of tadpoles in various stages of development into thyroidectomized tadpoles. Transplantation of the thyroids of very young tadpoles had no effect. However, transplantation of the thyroid of a tadpole undergoing metamorphosis brought about complete metamorphosis of a thyroidectomized tadpole. This shows that the thyroid of the very young animal contains insufficient hormone to induce metamorphosis.

Increasing activity of the thyroid gland of the tadpole as metamorphosis progressed could also be demonstrated by histological study (Sklower, 1925).

In order to test the relation of the thyroid to different stages of metamorphosis, the thyroid anlage of tadpoles was transplanted from its normal situation to the tail. Thus the gland could be removed at appropriate intervals after the onset of changes. After the legs were well developed, subsequent removal of the thyroid did not prevent the completion of metamorphosis (Hoskins, 1922). If the gland was removed prior to the development of the legs, metamorphosis was incomplete.

The relationship of the thyroid to molting has been examined in the newt *Triturus viridescens* (Adams, Richards, and Kuder, 1930). Thyroidectomy inhibits shedding of the skin. The animals lacking thyroid became gradually blacker, as layer after layer of cornified cells is formed and not sloughed off. Thyroid glands of normal newts transplanted into thyroidectomized animals will induce a complete molt of the many-layered epidermis.

Neoteny, which is the retention of the larval form either permanently or for periods far beyong the normal time required for metamorphosis, has been studied by the method of induced metamorphosis. We can distinguish between partial neoteny, when the animal is simply retarded in metamorphosis beyond the normal time and passes the winter as a tadpole, and total neoteny, in which case the animal retains its gills and other larval characteristics, becoming sexually mature in this condition. Partial neoteny is quite common in some frog species, such as *Rana catesbiana*. The classical example of total neoteny is the axolotl, the larva of *Amblystoma mexicanum*. The Mexican variety of this salamander never undergoes metamorphosis spontaneously. Axolotls may live for ten years, breeding in captivity from generation to generation in the larval state. It was shown by Babak, in 1913, that a single meal of mammalian thyroid suffices to induce metamorphosis. The first shedding of the larval skin takes place about 9 to 13 days later, and metamorphosis is pracically complete within 4 to 6 weeks.

The case of the axolotl raised the possibility that the perennibranchiate genera—*Proteus*, *Necturus*, and *Typhlomolge*—may in reality be sexually mature larval forms with a deficiency of the endocrine mechanism responsible for metamorphosis. Of these urodeles the species *Proteus auguineus* and *Necturus maculatus* have thyroid glands. By grafting the thyroids of *Necturus maculatus* into bullfrog larvae, Swingle (1922) showed that they contained a substance capable of inducing metamorphosis of the bullfrog larvae. Prolonged thyroid feeding has no effect on *Proteus* or *Necturus* (Hogben, 1929). The extreme case is that of the perennibranchiate *Typhlomolge rathbuni*, in which the thyroid seems to be congenitally lacking (Swingle, 1922).

There has been much speculation as to the cause of the failure of neotenous amphibia to metamorphose. In the case of the axolotl it may be that

the amount of thyroid hormone produced by the animal's own gland is too small to induce the specific changes in the tissues. There is suggestive evidence for this in the work of Rolič (1927), who induced metamorphosis of an axolotl by transplanting many thyroid glands of the same species. In the perennibranchiate the tissues have apparently lost the faculty to respond to thyroid hormone.

In the urodeles which always undergo metamorphosis spontaneously, such as *Triton alpestris* or *Salamandra maculosa*, metamorphosis can be accelerated through thyroid feeding (Kuhn, 1925). A synopsis of the findings on Urodeles is given in Table 1 (from Fleischmann, 1937).

TABLE 1

Thyroid physiology in urodeles

SPECIES	THYROID GLAND ACTIVITY AS DEMONSTRATED		METAMORPHOSIS SPONTANEOUS	INDUCED BY THYROID FEEDING
	By histology	By bio-assay*		
Triton alpestris	+++	++	+	+
Salamandra maculosa	+++	++	+	+
Amblystoma mexicanum	+	+	0	+
Proteus anguineus	+	−	0	0
Necturus maculatus	+	+	0	0
Typhlomolge rathbuni	Thyroid absent		0	−

* The activity was estimated by the effect of the transplanted glands on the metamorphosis of tadpoles.

REPTILES

Comparatively little work has been done on thyroid activity in this class of vertebrates. Noble and Bradley (1933) have studied the effect of thyroidectomy on molting in the lizard *Hemidactylus brookii*. Thyroidectomy lengthens the periods between molting, but never prevents molting entirely. Injections of thyroxin bring a return of the molt to its normal periodicity. However, neither injections of thyroxin nor implantations of fresh lizard thyroid increase the frequency of molt in the intact lizard. Eggert (1933) has studied the correlation between the histological changes and molting in lizards of the genus *Lacerta*. He finds that the thyroid undergoes cyclic changes parallel to those of the skin. At the time of shedding the old skin, the thyroid is comparatively inactive. The onset of maximal activity coincides with the fourth or fifth day after molting. Atrophy of the ovaries as a result of the administration of thyroxin has been described in the horned lizard, *Phrynosoma cornutum* (Mellish and Meyer, 1937).

BIRDS

The effects of experimental hyperthyroidism on the plumage of birds have received the attention of numerous workers during the last 20 years. The earlier work has been comprehensively reviewed by Zawadowsky (1932) and by Schneider (1939). Thyroid feeding or thyroxin injections in birds result in molting, acceleration of feather regeneration, and changes in the pattern and structure of the regenerated feathers. Zawadowsky and Rochlina (1927) carried out extensive experimentation on different species of birds and found that domesticated birds, such as chickens and pigeons, are more sensitive to thyroid than wild birds, such as the common crow. Even large doses of thyroid do not produce any molting in crows, although considerable depigmentation of feathers occurs.

The interaction between testicular and thyroid hormones has been studied by Jaap (1934). He found that pigment deposition initiated in the gray breast feathers of the Mallard drake is enhanced by urine extracts high in androgen. Completely castrated drakes showed no pigment deposition after administration of thyroid. Non-castrated drakes receiving similar treatment showed an increase in feather pigmentation. On the other hand, the reactivity of the crests of capons towards androgens is partly conditioned by thyroid hormones. A thyroidectomized capon requires a greater amount of androgen than a control, for the same response (Caridoit and Regnier, 1941).

A clarification of the action of thyroxin on plumage has been achieved by the studies of Lillie and Juhn (1932). These investigators employed the method of injecting subcutaneously hormones of known concentration into fowls at definite time intervals after plucking. In this way, regenerat-

ing feathers of known age are exposed to the hormone, and a record may be obtained in the definitive feather of the physiological events taking place during its formation from the feather germ. The saddle feathers of the Brown Leghorn male are used in this work. Following the injection of thyroxin, barbules are formed in regions normally free of barbules. With increasing doses of thyroxin black pigment appears. Barbule formation and pigment deposit follow each other in order of increasing thyroxin concentrations. Barbule formation may occur alone, but pigment formation is always associated with barbule formation.

Parkes and Selye (1937) were the first to observe that the morphological effects of thyroidectomy in fowls comprised loss of barbules, leading to fringing and elongation of the feather in relation to width.

Blivaiss (1947) has studied the effects of complete thyroidectomy on Brown Leghorns which had undergone thyroid removals on the fourth to twentieth day after hatching. Thyroidectomy delays the appearance of definitive feathers, juvenile feathers in all regions persisting longer than normal. Juvenile feathers show a decrease in melanin and barbules and an increase in red pigment. In the adult thyroidectomized rooster, body contour feathers show a loss of melanin, which is replaced by a red pigment, and of accompanying sheen. These feathers also show a decrease in the number of their barbules, resulting in a hackled, fluffy appearance and a tendency to become elongated, narrow, and tapered. Some feathers not only show a decrease in barbules but also a reduction of hooks. In the thyroidectomized hen the contour feathers show the same type of modification as do the feathers of the thyroidectomized rooster. A striking similarity of the breast feathers is observed in both sexes, both the black color of the male and the salmon color of the female being replaced by red pigment.

Thiouracil has the same effect on the plumage of the Brown Leghorn capon as thyroidectomy. Black pigment is replaced by red pigment. After discontinuing the drug, black pigment reappears (Juhn, 1944).

In pigeons the basal metabolic rate is depressed after removal of the thyroid. Values of −20 per cent were observed one week after operation (Marvin and Smith, 1943).

Brown Leghorn males suffering from leucosis show a characteristic change to red in the black plumage tracts of their bodies. Thyroxin causes a return to black in such abnormal feathers (Juhn, 1942).

The effect of thyroid deficiency in chicks has been studied with the aid of thiouracil (Astwood, Bissell, and Hughes, 1944). One-tenth of one per cent thiouracil in the food induced maximal enlargement and hyperplasia of the thyroid gland and a decrease in its iodine content. When given as a 0.5 per cent mixture in the food, growth and development were markedly retarded; wattles, combs, and spurs failed to develop, muscles were weak, joints hypermobile, and finally the chicks became unable to stand. A fringe of wing feathers grew during the first few weeks, but the down persisted and body feathers did not appear. This condition was interpreted as a state of cretinism. The amount of thyroxin necessary to keep the thyroid weights of thiouracil-fed chicks at normal levels was determined by Mixner, Reineke, and Turner (1944). They estimated the average daily thyroxin output of the male White Plymouth Rock chick thyroid at about 2 to 3 micrograms per day up to the age of 14 days. It was also noted that feeding of thiouracil to hens leads to thyroid enlargement in their chicks (Andrews and Schnetzler, 1945). The authors came to the conclusion that thiouracil is transmitted through the egg.

An interesting action of thyroxin in fowl was observed by Fleischmann and Fried (1945). Thyroxin, when administered simultaneously and in equal amounts with estradiol dipropionate in immature chicks, inhibits the ability of the estrogen to increase the plasma calcium, inorganic phosphorus, protein phorphorus, lipid phosphorus, and cholesterol, but does not inhibit the growth of the oviduct. In pigeons, thyroxin was observed to inhibit estrogen-induced changes in the plasma levels of calcium, neutral fat, and all phosphorus fractions, without inhibiting the action of estrogn on the formation of endosteal bone and promotion of the growth of the oviduct (McDonald, Riddle, and Smith, 1945). The estrogen-induced changes in the plumage of Brown Leghorn capons are not modified by the simultaneous administration of thyroxin (Caridroit, 1940; Fleischmann, 1946). These findings indicate that the inhibiting effect of thyroxin is confined to metabolic changes, whereas the structural changes brought about by estrogen are not affected. It therefore seems improbable that thyroxin is a physiological antagonist of estrogens.

A condition in fowls comparable to sporadic cretinism in human beings was described by Landauer (1929). He made careful anatomical studies of a dwarfed Rhode Island Red pullet. The bird exhibited a general arrest in growth, a striking brachycephaly, and myxedematous swelling of the skin. The skin was dry. Measurements of the skeleton showed marked deviations from the normal, similar to those found in human cretins. Endochondral ossification was suppressed. The thyroid was enlarged, and the greater part of the gland consisted of entirely aplastic tissue without any colloid.

MAMMALS

Studies on the effect of thyroidectomy in mammals are closely related to the problem of thyroid deficiency in human beings. Numerous workers tried to duplicate the clinical picture of cretinism (congenital deficiency of the thyroid gland), and of myxedema (acquired deficiency of the thyroid gland). Extirpation of the thyroid gland in young mammals is followed by the structural and metabolic changes characteristic of juvenile hypothyroidism. However, few authors have been able to reproduce the symptoms of adult myxedema in experimental animals. The influence of age on the effects of thyroidectomy varies in different species of mammals. The influence of age and of species on the results of experiments on hypo- and hyperthyroidism in mammals will be reviewed in the following paragraphs.

One of the first to make a comparative study of the effects of thyroidectomy was Horsley (1886). He divided animals into four classes in their relation to the results of complete removal of the thyroid gland. According to him, birds and rodents show no ill effects. In the Ungulata—sheep, goat, donkey, pig—the symptoms develop very slowly. There is general cachexia, which finally results in death after many months. In a third class, which includes the Primates, the effects are more severe. Myxedema is a marked feature, with increasing cachexia, ending in death. In the Carnivora, removal of the gland is followed in a few days by acute nervous symptoms characterized by severe tetany and convulsions, with an early fatal termination. These results made it seem probable that food habits are related to the effects of removal of the thyroid gland. Gley (1891) was, however, the first to point out that the reasons for these differences were mainly anatomical. No account had been taken of the thyroids and parathyroids as separate organs having independent functions. Furthermore, the different anatomical situation of the parathyroid bodies in the rabbit and the dog had not been taken into consideration. As Gley (1891) understood it, in the rabbit thyroidectomy had been performed; but in the dog, thyro-parathyroidectomy. In the rabbit, location of the parathyroid bodies at some distance from the lower lobes of the thyroid was responsible for the fact that previous workers had left them untouched in removing the thyroid tissue.

The next important advance in this field was the discovery of the internal parathyroids by Kohn, in 1895. He showed that in addition to the glandules described by Sandström (1880), there were two additional bodies of the same structure embedded in the thyroid. According to Kohn, one pair of parathyroids is embedded in the thyroid substance (internal parathyroids). Another pair (the external parathyroids) is situated at some distance from the thyroid in the Herbivora, but lies on the surface of this gland in the Carnivora. Furthermore, Kohn demonstrated the separate embryological origin of the thyroids and parathyroids. The Italian investigators Vassale and Generali (1896) were the first to perform complete parathyroidectomies on the basis of Kohn's work. They extirpated both internal and external parathyroids in cats and dogs. The animals presented a typical syndrome. Fibrillary contractions and muscular spasms, rigid and uncertain gait, tachycardia, rapid emaciation, and death occur within a few days. Death occurred in most of the dogs on the third or fourth day after operation; in most of the cats on the fifth day following operation.

Horsley in 1886 called attention to the influence of age on the results of what he believed to be thyroidectomy in Carnivora, but of what was in reality thyro-parathyroidectomy. He states: "I find that the determining factor, par excellence, of the value of the gland as regards its influence on the general metabolic processes of the animal is age. The effect of removing the gland in the young animal is the rapid appearance of violent nervous symptoms and death in a few days; in an older animal, e.g., a one-year old dog, the symptoms are less violent, later in their appearance and the animal survives perhaps for a fortnight or three weeks; in a very old animal the re-

moval of the gland simply hastens the torpor of old age. These observations refer to cats and dogs." Berkeley and Beebe (1908) stated that the symptoms following total parathyroidectomy are more severe in young than in old dogs.

Considerable experimental evidence has accumulated to prove that the young mammal is less sensitive to the administration of the thyroid hormone than the older mammal.

Bodansky and Duff (1936) showed that rats, 22 to 36 days old at the beginning of thyroid treatment, continued to grow even when given injections of 1 mg. of thyroxin daily. The same dose caused rapid loss of weight and death in adult animals weighting five to ten times as much. Abderhalden and Wertheimer (1929) reported that, given a dose of thyroxin 0.25 mg. daily, young rats of from 20 to 50 g. body weight increased steadily in weight; whereas older rats weighing about 100 g. showed a standstill or slight decrease of bodyweight on the same dose of thyroxin. Belasco and Murlin (1941) found that the increase in basal metabolic rate produced by a given dose of thyroxin (2 mg. per kg. bodyweight) was significantly less at 2 months of age than at 18 months. Loss in bodyweight during the administration of thyroxin is also influenced by the age of the animal. The younger the animal, the more resistant it is to weight changes.

LeBreton and Schaeffer (1935) have made studies on the effect of thyroxin on rabbits of different age groups. A single injection of 2 mg. per kg. bodyweight into rabbits weighing less than 350 g. produced no change in B.M.R. In rabbits weighing from 350 to 600 g., the increase in B.M.R. was 15 per cent; in rabbits from 650 to 800 g., the increase was 25 per cent. In adult rabbits, the same dose of 2 mg. per kg. bodyweight produced an elevation of B.M.R. up to 52 per cent. Similar results were reported by Roelandts and de Waele (1936).

Mark (1925) found that a dose of thyroid extract which had no effect on the N-balance of dogs up to the age of 4 months, produced a negative N-balance in a dog aged 6 months. Marine (1939) has stated as a general principle that immature animals are less sensitive to thyroxin than adults. Mautner (1941) stresses the increased resistance of children to thyroxin as compared to adults.

These findings are in accordance with the assumption of a higher level of thyroid function in the young animal. The sensitivity to thyroxin is inverse to the level of the thyroid hormone in the body. Means and Richardson (1938), in their monograph on thyroid diseases, state that "the effect of the hormone, as would be the case with any catalyst, is greatest, when its concentration at the start is lowest." It has been shown that sensitivity to thyroid medication, as measured by the response of serum cholesterol, is greater in patients suffering from hypothyroidism than in normal controls (Wilkins, Fleischmann, and Block, 1941). In a hypothyroid child a single dose of thyroxin causes a noticeable decrease in serum cholesterol. This effect lasts for a period of about forty days before the cholesterol returns to its previous high level. In a normal child the same dose of thyroxin causes only a slight and transient lowering of the level of cholesterol. The greater sensitivity of hypothyroid animals in comparison to normals has also been demonstrated in rats (Smith, Greenwood, and Foster, 1927), and in rabbits (Fleischmann, Shumacker, and Wilkins, 1940).

An important contribution to this problem is the finding of the MacKenzies (1943) that the rate of thyroid weight increase in rats due to administraction of sulfaguanidine decreases with age. The thyroid hyperplasia which occurs under the influence of sulfaguanidine is considered to be compensatory to the failure of thyroid hormone synthesis. Therefore the smaller increase in thyroid weight in older rats may indicate a decrease of the amount of thyroid hormone required by the tissues of older animals. The blocking of thyroid hormone synthesis by some of the sulfonamides and by thiourea and its derivatives should prove a powerful tool in studying the influence of age on the effects of thyroidectomy in various species. Experimental cretinism has been produced in rats through continued administration of thiouracil from the time of birth (Dempsey and Astwood, 1943, Hughes, 1944). The maintenance or restoration of normal thyroid weight by the administration of thyroxin simultaneously treated with thiouracil has been used by Dempsey and Astwood (1943) as the basis of an assay procedure for thyroid hormone. A quantity of thyroid hormone equivalent to 5.2 micrograms of thyroxin daily was required to maintain a thyroid of normal weight in young male rats kept at room temperatures averaging 25°C. This value is considered to be quantitatively equivalent to the amount of

hormone produced by the normal thyroid gland under these conditions.

By far the greatest number of experiments have been carried out on the rat. Hammett (1926) removed the thyroids and parathyroids of rats at 23, 30 50, 65, 75, and 100 days of age. All of his experimental animals were sacrificed at the age of 150 days. Hammett came to the conclusion that "the older the animal at the time of the initiation of the glandular deficiency, the greater the subsequent retardation of growth in body weight, body length and total length." A comparison of the weight gained by the operated rats with the weight gained by the controls in the same time period shows that the relative increase is not as high in the older operated animals as in the younger ones. Salmon (1938) has re-examined Hammett's data and finds that the statistical treatment of these data is open to some criticism. She has taken the data from Hammett's table and plotted the absolute average weights of all of his experimental series. A striking similarity in their trend is thus revealed. There is less actual difference between the curves of the average weights of the operated animals than between the respective curves of the unoperated normal groups. The average growth curves of the control groups differ widely and indicate that the quality of the animals used in the different experimental series was not uniform. A comparison between separate groups is of doubtful validity when the members of one of the normal control groups show developmental disadvantages which made them resemble the experimental animals of another group. In a later paper, using the mortality rate after thyro-parathyroidectomy and parathyroidectomy in the rat as a criterion, Hammett (1927) came to the conclusion that the effects of glandular deficiency are more severe in the young than in the older rat. A decrease in mortality rate accompanies the increase in age at the time of the initiation of the glandular deficiency. This experimental result is correlated, according to Hammett, with the occurrence of idiopathic tetany in man. This is in good accordance with the finding that young rats are more susceptible to cataract formation, due to parathyroid deficiency, than older animals (Goldmann, 1929).

Salmon (1938) has analyzed the body growth of new-born thyro-parathyroidectomized rats. Rats are well adapted for these studies because they are very immature at birth, and the characteristic structure of the thyroid develops only during the last three days in utero (Kull, 1926). The new-born thyroidectomized rat has had very little, if any, benefit of its own thyroid. Growth of the rats thyro-parathyroidectomized at birth reaches a growth plateau after three weeks. This represents the inherent growth capacity of the organism. Normal growth response was not obtained when new-born thyro-parathyroidectomized rats were given either thyroid or parathyroid hormone alone. Normal growth curves were obtained only when they were given both the thyroid and parathyroid hormones. Pituitary implants administered to new-born thyro-parathyroidectomized rats after weaning time did not produce a growth response if the animal was completely thyroidectomized. Only where thyroid remnants were present was a growth response obtained. This was in contrast to experiments of Smith (1933), who obtained growth in thyroidectomized rats with anterior pituitary implants. However, Smith's rats were considerably older (40 days), when their thyroids were removed. Salmon offers the explanation that the thyroid may be the predominant influence in the early stages of development during the first days after birth. Later the pituitary may become independent of the thyroid and predominant in the expression of the developmental pattern inherent in the tissues of the body. Another factor considered by Salmon is the response capacity of these tissues. It may well be that the body tissues as the end organs of hormonal actions need to be primed with thyroid before they can respond to pituitary growth hormones. The older thyroidectomized rats of Smith (1933) had the benefit of thyroid until shortly before the pituitary replacement test. Compared with these older animals, Salmon's newborn rats had been explosed only for a short time to thyroid hormone.

Subcutaneous injections of thyroxin in normal female rats over a period of 251 days caused no perceptible increase grossly or histologically in the rate of endochondral ossification in the tibia or the rib of the rat. Rats on whom thyro-parathyroidectomy had been performed at the age of about 40 days showed marked dwarfism after a postoperative period of 330 days. Histologically, the picture of endochrondral ossification resembled that following hypophysectomy, although the changes were not as severe—decrease in the size of chondrocytes, deposition of bone along the zone

of erosion, very light formation of cancellous bone, and marked increase in the fat content of the marrow. Injections of thyroxin were followed by a return to the normal in gross and histologic appearance. Injection of thyroxin in rats from which not only the thyroid and parathyroid but also the pituitary gland had been removed, had no effect in repairing the growth defect (Becks, Ray, Simpson, and Evans, 1942). Feeding of thyroid does not produce a specific catabolic effect upon the calcium deposits in the bones of normal rats, if the calcium intake is adequate (Smith and McLean, 1938).

Hypothyroidism induced by thiouracil has no effect upon the reproductive system of the adult male rat, as judged by the ability to sire litters. Prolonged thiouracil administration, associated with hypothyroidism, in the adult female rat, does not cause sterility but does interfere with continuation of gestation, causing the resorption of embryos (Jones, Delfs and Foote, 1946).

In young rabbits thyroidectomy produces very similar changes in growth and development to those observed in man. Basinger (1916) removed the thyroid from rabbits at the age of two to three weeks. Two weeks after operation the hair was noticeably drier and did not lie flat and smooth on the skin, as in normals. By the tenth week the average weight of the cretin is 750 g., as against 1400 g. in the untreated controls. The hair becomes coarse, and the skin becomes dry, thick, and scaly. The abdomen grows out of proportion to the rest of the body, and gradually a "pot belly" develops. The animals are sluggish and move about very reluctantly. No myxedematous changes of the skin were noticed. This is in confirmation of older work of Hofmeister (1894), who in addition to noticing the clinical signs of juvenile myxedema mentioned above observed hypertrophy of the pituitary gland and disturbance in the growth of the cartilage of the epiphyses, with a retardation of normal cell growth and a swelling vacuolization of the cartilage. It is of interest that Hofmeister's studies on rabbits indicate a disturbance in the cartilage. He describes this condition as chondrodystrophia thyropriva. A disturbance in the cartilage just prior to ossification has been more recently postulated by Wilkins (1941), as a result of his studies of roentgenograms of hypothyroid children. This disturbance is presumably the cause for epiphysial dysgenesis associated with hypothyroidism. This condition is manifested by the appearance in the cartilages of multiple irregular islets of ossification scattered over a large area. These enlarge and coalesce to form an irregular, spongy, porous, or fluffy mass. Hunter and Sawin (1942) have made a careful study on the effects of thyroidectomy on the skull of the domestic rabbit. An analysis of skull contour in thyroidectomized rabbits indicates the presence of different degrees of retardation in proportion to the rate of growth, both in bones preformed in cartilage and in membranes. The anomalies of the skull, teeth, and jaws arising under this condition are due to a general lowering of physiologic activity, which includes a restriction in the internal resorption of bone, but which does not include the continuously growing teeth. Developmental anomalies arise as a consequence of the slow growth of skull and jaws and the normal growth of teeth.

The rabbit is the only mammal in which pigmentation changes due to thyroid hormones have been reported. Iljin (1932) found that desiccated thyroid fed in large doses (0.56 g. daily) produced growth of white hair instead of black on the ears of the black Russian rabbit. The metabolic changes in the adult rabbit resemble closely those observed in human beings. The rabbit has no accessory thyroid tissue, and total thyroidectomy can be performed without risk of hypothyroidism. Marine and Lenhart (1920) observed that on the fifth to seventh day after thyroidectomy the basal metabolic rate begins to fall and reaches its lowest level, of about 35 per cent below the preoperative level, between the 20th and 30th days after thyroidectomy. Fleischmann, Shumacker, and Wilkins (1940) found that changes in serum cholesterol due to thyroidectomy resemble the changes in hypothyroid human beings after withdrawal of thyroid treatment. Thyroidectomy in the rabbit is followed by a sharp rise from the preoperative level of from 60 to 100 mg. per cent to levels of from 140 to 280 mg. per cent. After the first rise, the serum cholesterol fluctuates markedly, finally becoming stabilized after about 12 weeks at a value of about 180 mg. per cent. Experiments on the relationship of serum cholesterol to total body cholesterol in thyroidectomized rabbits suggest that the thyroid hormone influences the shift of cholesterol from the blood plasma into the tissues, rather than that it has a specific effect on cholesterol metabolism (Fleischmann and Shumacker, 1942). Like hypothyroid human beings

(Wilkins, Fleischmann, and Block, 1941), thyroidectomized rabbits are more sensitive than normals to a single injection of thyroxin, as can be shown by following the changes in the basal metabolic rate, serum cholesterol, and creatine excretion (Fleischmann, Shumacker, and Wilkins, 1940).

The effects of thyroidectomy on the reproductive organs in males of the annual-breeding ground squirrel, *Citellus tridecemlineatus*, have been studied by Zalesky and Wells (1937). Thyroidectomy was performed during a period of sex quiescence. In some cases the parathyroids were removed also, and calcium was administered. The experimental animals did not show the high degree of sexual development attained by the controls during the breeding period. There was no evidence of spermatogenesis or of androgenic effect.

The importance of the thyroid gland in the phenomenon of hibernation has formerly been overemphasized. The thyroid of the mammal during hibernation is characterized by considerable flattening of the cells and a diminution of colloid. It is also true that injection of thyroid hormone can produce awakening of the hibernating mammals, but this effect is hardly specific. Various other stimulants have the same effect. The interesting finding of Uiberall (1934), that hibernation also occurs in thyroidectomized hedgehogs, proves that this cyclic condition cannot be caused primarily by changes in thyroid function. The changes in the histological appearance of the thyroid are most likely one of the signs of decreased activity of every organ of the hibernating animals. An excellent review of the physiology of hibernation has been published by Gorer (1930).

Older workers (Biedl, 1913) have stressed the difference in the effect of thyroidectomy on the young and on the adult dog. This finding has been confirmed by the careful studies of Binswanger (1936). Adult dogs survived thyroidectomy with conservation of the parathyroids for 12½ to 19 months. Dogs operated at an earlier age than four months show marked signs of deficiency, especially in growth and ossification. If thyroidectomy was performed at an age of over four weeks there was no disturbance in the growth curve. Binswanger did very careful autopsies of all of his dogs to rule out the presence of accessory thyroid. He emphasized the point that the weight of the thyroid is 0.18 to 0 19 per cent of the body weight during the first weeks of life, and only 0.02 per cent from the fifth week on.

The basal metabolic rate of the adult dog shows only a moderate drop after thyroidectomy (to −17 per cent) (Grafe and von Redtwitz, 1922). The rise in basal metabolic rate due to exposure to cold is the same in thyroidectomized dogs and in the unoperated controls. A rise in the blood lipids of the adult dog after thyroidectomy has been reported (Chaikoff et al., 1941). Total thyroidectomy or use of the antithyroid drug, thiourea, do not produce in the adult dog any syndrome comparable to myxedema in human beings (Danowski, Man, and Winkler, 1946). According to these authors the metabolic processes of the dog are less dependent on the thyroid hormone than those of man. Difficulties in forming conditioned reflexes in the thyroidectomized dog were described by Asimoff (1928).

Complete thyro-parathyroidectomy has no effect on the adult fox; autopsies showed that no discoverable remnants or accessory glands had been left behind (Carlson and Woelfel, 1910).

Thyroidectomy of ungulates has shown very clearly the influence of the age factor on the effects of thyroidectomy. In young goats and sheep, Von Eiselsberg (1895) observed symptoms strongly resembling cretinism in man. Von Eiselsberg describes sheep operated at the age of 10 days with a marked retardation of growth and mental sluggishness. At autopsy retardation of osseous development and atherosclerosis of the aorta were the most significant findings. In goats operated at the age of three weeks, retardation of growth could be observed one month after operation. Four months after operation the control animal weighed double the amount of the thyroidectomized kid. The growth of the extremities was more retarded than that of the trunk. The abdomen had the appearance of being inflated. Sexual development was retarded, as was growth of the horns, both in sheep and goats. The striking difference in the effects of thyroidectomy in sheep and goats, according to Von Eiselsberg, is in the effect on hair growth. Development of hair was very poor in the thyroidectomized sheep. In the thyroidectomized kids, however, the hair grew much longer than in the controls but could be pulled out very easily by hand. The only physiological observation on the thyroidectomized kids was a lowering of the body temperature. Similar observations on goats thyroidectomized

at the age of six and eight weeks were made by Pick and Pineles (1909). They also recorded myxedematous swelling of the skin. A careful investigation of the effects of thyroidectomy on sheep and goats was made by Simpson (1913). He removed the thyroids, including the internal and the external parathyroids, from four lambs and four adult sheep. The lambs all showed acute symptoms shortly after the operation and died. In the adult sheep such results were not noted during the time they were under observation—three to four months. In the adult sheep complete removal of the thyroid and parathyroid glands produced no signs resembling myxedema in the human subject. No lowering of the body temperature and no tendency for the wool to fall off were noted. No mental symptoms were observed; the operated animals stayed alert and brisk in their movements. They gave birth to full-term healthy lambs, which they suckled.

In 1924 (a, b) Simpson published further experiments on this subject. In sixteen pairs of twin lambs, the thyroid gland was removed from one animal of each pair, and the other was kept as a control. The external parathyroid was conserved in these experiments. When the operation was performed from three to four weeks after birth, marked stunting resulted. In more than one instance, the weight of the control was three times that of the cretin. When thyroidectomy was delayed until the third or fourth month the retardation of growth was only slight. If thyroidectomy with conservation of the external parathyroids was performed on young adult sheep or on lambs at the age of six to seven months, for about a half year subsequent to the operations nothing in the general appearance of the animal would suggest that the thyroid gland had been removed; if kept alive for a year or longer, chronic changes, ovine myxedema, would appear. The hind limbs became swollen, the movements became slow and clumsy, the musculature flabby, the gait quite unlike that of normal sheep. The rapidity with which symptoms develop seem to depend on the age at which the operation is performed. Simpson reiterated his earlier statement, that in old adult sheep the thyroid gland may hardly be missed. Some degree of slowing of the pulse may be the only sign of thyroid deficiency.

Marston and Pierce (1932) have studied the effects of thyroidectomy in adult merino sheep. Mature merino sheep, operated at the age of 12 months, suffered little obvious change in their appearance. The amount of wool fleece grown was decreased. The B.M.R. became markedly retarded, and dropped to −40 per cent in some cases. Young merino sheep showed stunted and considerable changes in appearance, resembling cretins in human beings. The wool was reduced considerably without evident decrease in fibre diameter, and the degree of greasiness of the fleece was definitely lessened. No symptoms of oedematous infiltration of the integument were observed in any of the operated animals. One pair of parathyroids embedded in the thymus was left intact in these experiments.

Todd, Wharton, and Todd (1938) have made a detailed study on the skulls and skeletons of the sheep on which Simpson made his studies on growth. The authors based their study upon the bones of five pairs of twin sheep, one of each pair being thyroidectomized in early life. The general results of thyroidectomy are deficient growth and modelling of the epiphyses themselves, defective development of age characters on both epiphyses and adjacent shaft, and diminished velocity of growth and shaft. There is no modification of bone texture, weight, thickness of modelling of shaft, and no prolongation of the growth period to compensate for diminished velocity. The locus of damage to both growth and maturation patterns is definitely the diaphysio-epiphysial plane. The direct effect of hypothyroidism is probably restricted purely to the modification of growth velocity. The effect on maturation seems to be indirect, produced through disturbance of the bodily endocrine pattern.

The effect upon the growth pattern of the skeleton is to produce what seems to be a progressively more marked inhibition but is really an inhibition of velocity without prolongation of the growth period. The result is to reduce the proportions of the limbs to those of the unimproved wild sheep of little meat or wool value. The effect on maturation is to reduce velocity approximately by one-half. Probably like the growth impulse, maturation progress in the skeleton ultimately fades out. Obvious pathological changes in the diaphysio-epiphysial plane are not evident until the animal is two years old or more. The pathological features are irregular exuberances on the shaft end resembling proud flesh, inturned, clawed, trachoma-like epiphysial margins, and a small,

poorly modelled, ill-fitting epiphysis scarcely covering the shaft end.

It is of interest that the formation of a simple tactile conditioned reflex is effected as easily in the thyroidectomized as in the normal sheep (Liddell and Simpson, 1926).

Simpson removed the thyroids from two of triplet female goat kids at the age of 20 days. A difference in growth rate was detectable on the nineteenth day following operation, and from that time on the normal kid rapidly outgrew the cretins. Moussu (1892) produced the signs of myxedema in a goat operated at the age of ten days; at the age of six months this animal looked like an animal one month old. Complete absence of cutaneous swelling (myxedema) was noticed.

It has been known for some time that thyroidectomy of the lactating goat causes a reduction in milk production (Grimmer, 1918). An interesting change in the composition of goats' milk following thyroidectomy was observed by Fasold and Heidemann (1933). Normal goat's milk contains vitamin A but no carotene; even if the diet is rich in carotene, none is excreted with the milk under normal conditions. The milk of thyroidectomized goats contains enough carotene to change its color to yellow; vitamin A, however, is absent from the milk after thyroidectomy. Recent investigations of the Missouri Agricultural Station (Ralston et al., 1940) showed that four weeks after thyroidectomy of the lactating goat, milk production had decreased 70.8 per cent. The heart rate decreased from 86 beats per minute to 80 beats, which is hardly a significant decrease. In these experiments the parathyroids were conserved. Larson and Elkourie (1928) have reported that in goats ranging in age from two to sixteen months complete removal of the thyroids and parathyroids does not result in tetany. Tetany does not supervene because the goat can maintain a normal or nearly normal level of blood Ca even in the absence of its parathyroids. Only the goats operated at 2 months showed evidence of cretinism.

According to Duerst (1941), thyroidectomy in lactating goats is a routine operation among Swiss veterinarians. The yield of milk is slightly decreased, but this milk is supposed to be beneficial to patients suffering from hyperthyroidism. The goats survive the operation for many years, but are more easily subject to infections than normal animals. Hypertrophy of the thymus is frequently observed as a consequence.

The influence of age on the effect of thyroidectomy is very marked in the pig. Moussu (1892) produced the complete picture of juvenile hypothyroidism, including swelling of the skin, in young pigs operated at the age of one month. In adult pigs, however, thyroidectomy had no marked effect. According to Caylor and Schlotthauer (1929), the signs of hypothyroidism produced in young pigs (aged two months) are largely influenced by the diet. On a diet low in protein, high in carbohydrate the controls gained 15.3 kg. in two months, the operated animals only 1.8 kg. The operated animals did not develop cutaneous swellings (myxedema) and remained mentally alert. On a diet high in protein, low in carbohydrate, the young pigs developed the edema of myxedema and became stupid, inert, and lost their natural curiosity. Caylor and Schlotthauer make the interesting suggestion that the mental sluggishness may be due to the pressure of edema on the central nervous system.

Duerst (1941) has for many years thyroidectomized adult pigs and found that this enhances fat deposition. He had advocated thyroidectomy in pigs as a means of producing a greater amount of lard. From this angle thyroidectomy offers greater economical advantages than castration. Similar results have been recently reported by Mahrer and Hogan (1946), who fed rations containing 0.2 per cent thiouracil to growing swine. The test animals were shorter and fatter after 28 days of feeding.

The effects of iodine deficiency in pregnant sows on the offspring were studied by Smith in 1917. In some sections of Montana, hairless and otherwise defective pigs were born of apparently normal sows. They were strikingly weak and low in vitality. The most marked thing in the appearance of a typical specimen was the absence of hair. The skin was smooth, shiny, and bald. Only a few tactile hairs were present on the nose. The skin, particularly around the shoulders, was thick and felt pulpy. It was semi-transparent and seemed edematous, but no fluid escaped on incision. The hoofs were thin-walled, short, brittle, and plainly in an undeveloped condition. The heart in every case examined had a persistent foramen ovale. The thyroid was dark red and presented a most constant enlargement. Microscopically a uniform hyperplasia and distension of the blood vessels was manifest. Chemical analysis showed that the average iodine content of the thyroids of 36 affected pigs was 0.001 per cent, as against an iodine content

of 0.095 per cent in the thyroids of 44 normal newborn pigs. Administration of iodine during the gestation time prevented the occurrence of this condition in the afflicted area. The authors' conclusion that iodine deficiency caused a lack of function and hyperplasia of the fetal thyroid is convincing. The term "fetal athyrosis" used by Smith for this condition is, however, hardly well chosen.

Brody and Frankenbach (1942) compared the relative growth and development, metabolism, general appearance, and behavior of a Jersey heifer, thyroidectomized at the age of 45 days, with a normal control. At the age of 40 months the thyroidectomized animal was about half normal weight; its metabolism per unit surface area about 40 per cent below normal; it was completely undeveloped sexually. Feeding iodized milk protein following this age stimulated growth. Her metabolic rate was increased, her hair coat was no longer rough and coarse. There was considerable development of mammary gland and horn. Before feeding the iodinized milk protein, she had never been in heat, but has exhibited heat twice since then.

The effects of thyroidectomy of a male Jersey at the age of four months have been reported by Petersen et al. (1941). For approximately 60 days following thyroidectomy the animal behaved normally. After that time, however, symptoms of myxedema developed. The skin becme thick and puffy; the hair became dry, brittle, and sparse, and body fat increased. Complete apathy, especially lack of interest in females and of normal sexual behavior, were quite striking. Examination of the sperm revealed normal spermatogenesis. An increase of total fat and of cholesterol in the blood was noted.

Retardation of dental development was observed in colts thyroidectomized at the age of two months (Houssay and Hug, 1920).

A review of the older literature reveals conflicting reports concerning the effect of thyroidectomy on monkeys. Horsley in 1884 and 1886 was the first to report extirpation of the thyroid in monkeys. Besides symptoms of tetany, which would be referred today to lesions of the parathyroid, he observed gradual development of "the symptoms of the disease termed myxedema by Dr. Ord, and ordinary cretinism." Most of Horsley's experiments seem to have been on young monkeys (species not given), but he stated that "an older animal, if kept under ordinary circumstances, will survive for 6 or 7 weeks, dying at the end of that time of myxedema."

Murray (1893) noticed inactivity, swelling of the lips and eyelids, and anemia following thyroidectomy in a bonnet monkey (*Macaca radiata*). These symptoms were relieved by injection of thyroid extract. Edmunds (1900), who did not state what species of monkey he used, noticed swelling of the face in one of ten animals on which thyroidectomy was performed. Von Eiselsberg (1895) described an acute onset of symptoms of tetany and the gradual development of sluggishness and apathy following thyroidectomy in a young Barbary ape (*Macaca sylvanus*). Furthermore, Burford, Allen, and Diddle (1936) reported a marked increase of body weight and sluggishness in four adult female spayed rhesus monkeys (*Macaca mulatta*) after thyroidectomy.

On the other hand, Munk (1897), Kishi (1904), Halpenny and Gunn (1911), and Carlson and Woelfel (1910) have reported a series of negative experiments. In the older work the species worked on was not stated. Vincent and Jolly (1904, 1906) used both *Macaca* and *Cercopithecus;* Halpenny and Gunn, *Macaca mulatta*. Kishi stated that soon after operation convulsions occurred which sometimes killed the animals. The surviving animals never exhibited symptoms of myxedema or mental apathy nor any swelling of the skin. Munk (1897) made very careful autopsies and found no trace of thyroid tissue or only minute amounts in the seventeen animals operated on. Carlson and Woelfel (1910) found that a rhesus monkey in which a (presumably total) thyroidectomy had been performed showed no evidence of even "incipient myxedema."

Fleischmann, Shumacker, and Straus (1943) continued the study of the effects of total removal of the thyroid gland in adult rhesus monkeys by methods that had proved useful in studies on the thyroid function of human beings (Wilkins and Fleischmann, 1941a, b). Total thyroidectomy had no effect on the appearance, activity, basal metabolic rate, or serum cholesterol level. In man even incomplete thyroidectomy is nearly invariably followed by hypercholesterolemia. The rise of serum cholesterol occurs not only when toxic goiters are removed, but when the normal thyroid gland is removed in the treatment of chronic heart disease. In six adult rhesus monkeys no such change was observed following thyroidectomy. The mean of repeated serum cholesterol determinations was 123.9 ± 2.0 mg. per 100 cc. of serum

before operation, and 123.5 ± 2.0 mg. after operation. The completeness of the removal of the thyroid was demonstrated both by anatomic search and by physiologic tests with thyrotrophin. The monkeys were injected with thyrotrophic hormone of the pituitary to determine whether any thyroid tissue capable of responding to this factor was present. This method had been useful in gathering information on the presence or absence of functional thyroid tissue in dwarfed children. (Wilkins and Feleischmann, 1941c). In this work, Wilkins and the author had found an increase in creatine excretion to be the most sensitive measurement of thyroid effect. Thyrotrophin produced a great increase in creatine excretion in the rhesus monkeys only when tested before thyroidectomy. Administration of thyroxin, however, was followed by an increased creatine output both before and after operation. This indicates that following thyroidectomy there was either no thyroid left or only an amount insufficient to cause measurable effect after stimulation with thyrotrophin.

In addition to the adult rhesus monkeys, two young rhesus monkeys were thyroidectomized at the age of about eight months. Both animals showed a sharp rise of the cholesterol content of the serum following thyroidectomy. The level of serum cholesterol in one young monkey which survived the operation for 147 days reached a peak of 326 mg. per hundred cc. 5 weeks after operation. Complete cessation of growth was observed in this animal. These data suggest that the age factor is of great importance in determining the effect of thyroidectomy in the rhesus monkey.

The lack of marked effects of thyroidectomy on adult rhesus monkeys has been confirmed by Jailer, Sperry, Engle, and Smelser (1944). They worked on nine female rhesus monkeys, two of whom had their ovaries removed about one year before thyroidectomy. It is of interest that these two animals of this series were the only ones to show a gain in weight following thyroidectomy.

Recently Aranow, Engle, and Sperry (1946) administered thiouracil to four adult female rhesus monkeys in increasing doses up to 0.8 g. daily for 14 months. No significent changes in body weight or circulation time were observed during treatment. None of the monkeys showed any striking changes in degree of belligerence or of spontaneous activity. Menstrual irregularity was frequently observed during treatment. Hyperplasia of the thyroid gland of the rhesus monkey did not occur after treatment with 0.1 g. and 0.2 g. of thiouracil daily for 12 weeks. The thyroid gland of rhesus monkeys treated with 0.8 g. of thiouracil daily for 10 weeks showed severe hyperplasia (Engle and Aranow, 1946).

In human beings removal of the greater part of the normal thyroid gland in the treatment of chronic heart disease induces the signs of hypothyroidism. Gilligan, Volk, Davis, and Blumgart (1934) have made careful studies of the rise in cholesterol and the drop in basal metabolic rate after this operation. Their series include patients over sixty years of age who showed not only those changes in metabolism but also untoward clinical symptoms of myxedema. Raab (1945) has treated eight patients over sixty with thiouracil for relief of angina pectoris. In seven of these there was a marked response to the antithyroid drug, as evidenced by a drop in basal metabolic rate. Serum cholesterol showed a marked rise in one case, a woman of sixty-seven. It rose to a level of 619 mg. per hundred cc. Wilson and Mayo (1940), on the basis of 238 cases of postoperative myxedema followed at the Mayo Clinic, found that the estimated amount of thyroid tissue left at the time of operation was approximately 27 per cent of a normal lobe on either side in cases in which appreciable thyroiditis was not present. In cases of thyroiditis, the amount left was approximately 31 per cent of a normal lobe on either side. These data prove that even a considerable amount of active thyroid does not prevent the development of hypothyroidism in human beings.

CONCLUSIONS

Some general conclusions can be drawn from the experimental work reviewed in the preceding paragraphs.

The morphological finding that a thyroid gland occurs in all vertebrate animals is corroborated by physiological proof of thyroid function in all classes of vertebrates. The finding that radioactive iodine is stored in parts of the endostylar tissue of the ammocoetes larva is important for the problem of the phylogeny of the thyroid gland. The value of this work is emphasized by the negative results obtained in lower chordates. Their endostyle is incapable of storing iodine. We can agree with a recent formulation by Leach (1946), "that the endostyle of ammocoetes is the most primitive thyroid mechanism which possesses a chemically functional analogy with the

follicular type of gland so characteristic in adults of all craniates."

It is of interest that iodine is stored very early in the thyroid of free-living larvae like the tadpole. In mammals the beginning of thyroid function was determined by subcutaneous injection of radioactive iodine into pregnant rats. Iodine storage could only be demonstrated toward the end of fetal life. Iodine accumulation is initiated on the eighteenth or nineteenth day of fetal life in the Long-Evans strain of rats (Gorbman and Evans, 1941b). Definite histological features could be correlated with the ability to store iodine. Cells which were previously uniformly arranged in columns begin to arrange themselves into follicles. This work confirms previous studies of Kull (1926), who showed that follicle formation takes place with an almost explosive unfolding in the albino rat between the eighteenth and twenty-first days of fetal life. We cannot draw any generalizations from experiments on rats as to the onset of thyroid activity during the fetal life of mammals in general. It has been shown by Rumph and Smith (1926) that follicle and colloid formation take place in the thyroid of the pig in a much earlier stage of fetal life than in the rat. Extracts from pig embryos just showing follicle and colloid formation are biologically active. They stimulate metamorphosis in the hypophysectomized tadpole.

In the human embryo, the thyroid is differentiated histologically at the end of the third month of fetal life. If human thyroid is transplanted into tadpoles of the common toad at this stage, metamorphosis is induced (Schulze, 1930).

Whether or not absence or under-development of the thyroid gland during embryonic life leads to manifestations of hypothyroidism in human infants is a moot question. Wilkins (1941) found disturbances of ossification in the epithyses of the cuboid bone and the femoral and tibial epiphyses of the knee in young cretins. "The involvement of these centers, which are usually ossified prenatally, may point to the intrauterine existence of hypothyroidism but cannot be accepted as proof, because occasionally ossification of one or more of these centers is absent in normal children at birth."

A main problem of thyroid physiology is the relationship between the metabolic and the morphogenetic actions of the thyroid hormone. A number of papers relating to this problem, especially in reference to amphibian metamorphosis, has been discussed in the section on the Amphibia.

There is some older work suggesting a dissociation between the morphogenetic and the metabolic properties of thyroxin. Kendall (1919) synthesized an acetyl derivative of thyroxin, which is highly active in accelerating amphibian metamorphosis.

Swingle, Helff, and Zwemer (1924) made the interesting observation that this compound, acetylthyroxin, has no effect on the basal metabolic rate of normal adult men. Hoskins (1927) showed that the skeletal development of new-born rats can be accelerated by acetylthyroxin. This may indicate that acetylation may have neutralized the effect on metabolism, but not have changed the morphogenetic property of thyroxin. Experiments with acetylthyroxin and possibly with other thyroxin derivatives might shed some light on this important question.

Leach (1946) has concluded from his studies on lower vertebrates that the thyroid gland of the lower vertebrates is not so much concerned with the regulation of metabolism as it is with growth and differentiation. The ammocoetes larva of the lamprey is a good object for the study of this problem. The circumstance that the lamprey does not lose weight rapidly during metamorphosis affords a good condition for a study of oxygen consumption. In tadpoles, which have been generally used for studies on this problem, shrinkage is extremely rapid, and weight calculations are more subject to error.

Much evidence has accumulated throughout the last sixty years to prove the statement of Horsley (1886) that the value of the thyroid gland is more important to the young than to the older animal. Man seems to stand alone in showing severe deficiency symptoms after removal of the thyroid gland in later life. All other species of vertebrates seem to require the thyroid hormone only during the early stages of growth and development.

It is difficult to understand why man should be more dependent on the thyroid in later life than other mammals. According to Bolk (1921), the essential character of the human body is a survival of fetal conditions. This persistence of fetal conditions is the result of a retardation or a suppression of the development of certain general characters in Primates. The rate of development in man is retarded, with the consequence that the infantile or puerile phases of his life are prolonged. It may well be that the need of the adult human for thyroid hormone reflects this general retardation of development characteristic for the species.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will frequently appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to B. H. Willier, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, Homewood Campus, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

SERVING THROUGH SCIENCE. *A Series of Talks Delivered by American Scientists, on the New York Philharmonic-Symphony Program.*

United States Rubber Company. Free upon request (paper). 120 pp. 1946.

Included in this publication are 38 brief talks by outstanding scientists of the United States, made over the air during the intermissions of the New York Philharmonic-Symphony Orchestra programs during 1945. Some 20 of these are biological in character. All of the talks, of course, were planned to interest and be intelligible to the general public. The introduction of each scientist is included. Separates of individual talks are also available. The sponsor of these intermission talks is doing a highly praiseworthy service to the cause of science, and deserves every encouragement. The choice of speakers is a sufficient guarantee of unbiased, accurate reporting.

NEW IDEAS IN SCIENCE. *Our World of Science.*

By Gerald S. Craig and Margaret Oldroyd Hyde. Illustrated by Harold Sichel, Raymond Thayer, Joseph Guerry, Else Bostelmann, Ralph Shepherd, and Bernard Friedman. Ginn and Company, Boston and New York. $1.44. 377 pp.; ill. 1946.

Like the other books in this general science series (cf. Q. R. B. 21: 369. 1946), this one for the sixth grade is attractively illustrated in black and white and in color (about half in half) and has been carefully prepared. The style is somewhat freer here, the vocabulary suitably enlarged. Of the fifteen units included, only two are wholly biological, and only four additional topics introduce some biology. Most attention is given to physical and chemical concepts. The last chapter is a highly commendable essay on Using New Ideas, which endeavors to help create a suitable scientific attitude toward change.

The biological topics fall under the three general heads of health and hygiene, natural history, and conservation. It must be said again that, since health is often taught as a separate subject in the grades and since separate series of books dealing with it are available in abundance, the emphasis on health in this series is largely unnecessary. On the other hand, the presentation of fundamental biological material fares far worse here than that of the physical sciences. A better balance is needed.

BENTLEY GLASS

USING OUR WORLD. *Adventuring in Science. New Edition.*

By Samuel Ralph Powers, Elsie Flint Neuner, Herbert Bascom Bruner, and John Hodgdon Bradley. Ginn and Company, Boston and New York. $2.16. vi + 666 pp.; ill. 1946.

This attractively illustrated general science textbook for the ninth grade is a companion volume to *Exploring Our World* (cf. Q. R. B. 22: 60. 1947). The five units included here deal with Living Resources, Mineral Treasures, Putting Energy to Work, the Preservation of Health, and Conservation. Two new chapters have been added to the last section, one of them dealing with rubber substitutes, plastics, and electronics, the other with human adjustment to varieties of environment and to changing conditions.

This certainly must be a hard book to keep up to date. The present revision has nothing in the section on weeds about the new chemical weed killers, nothing in the section on insect control about DDT, nothing in the section on metals about the extensive use of magnesium (except for flash-bulbs), nothing about penicillin or sulfa drugs in the section on health and disease, and there is little more than a mention of atomic energy. American boys and girls certainly know about all or most of these new developments—they read about them in our popular magazines and in the comics, and they see them on every hand in movies and advertisements. Even if standard topics of yesteryear have to be curtailed or omitted altogether, these newer matters, by sheer force of interest and significance, will have to find a place. *Using Our World*, just revised, is thus due for an immediate and extensive overhaul.

BENTLEY GLASS

SCIENCE ON THE MARCH.

By John A. Clark, Frederick L. Fitzpatrick, and Edith Lillian Smith. Houghton Mifflin Company, Boston. $2.12. xvi + 620 + x pp.; ill. 1946.

This revised general science textbook, for ninth-year pupils in junior high school or high school, is planned to emphasize the march of science, the principles and methods of science, and scientific attitudes. It is organized in the form of problems grouped into larger units dealing respectively with Air, Water, Food, Sun Energy, Health, the Universe, Weather, Natural Resources, Communication and Transportation, Simple Machines, and Reproduction. Biological problems are presented in all but four of these. Each problem raises a question, such as "How do animals change the content of air?" and then presents the scientific evidence bearing upon it. Following the conclusions are Thought Questions, Review Questions, Applications to Daily Life, and suggested activities For Science Club and Leisure Time.

The illustrations are abundant and good. The style, however, is that monotonous repetition of short, direct statements and questions that is supposed, surely without warrant, to be necessary for anyone at this age to understand. It is difficult indeed to believe that it can appeal to a generation brought up on *Life* magazine. The inclusion of material also seems very little advanced over that to be found in science texts for lower grades. Is a fifteen-year-old too young to learn anything about atomic energy (there is a mention of it) or regarding the facts of life, e.g., mammalian reproduction or the existence of genes, chromosomes, and heredity? Again one thinks of *Life* magazine and its treatment of such subjects for a general public reputed to have a mental age of twelve to fourteen years. It seems that the *New York State Syllabus in General Science*, which these authors have followed, needs to be revised.

BENTLEY GLASS

BIOLOGY FOR BETTER LIVING.

By Ernest E. Bayles and R. Will Burnett. Scientific drawings by Ted R. Miller; other drawings by Edmund Monroe. Silver Burdett Company, New York, Chicago, and San Francisco. $3.20. xiv + 754 pp.; ill. 1941; 1946.

This is quite the best-illustrated high school biology textbook that has come to my attention. Both drawings and half-tones are outstanding of their kind, and provided in abundance. Young students should, therefore, feel an instant attraction toward the book.

The treatment and selection of material are somewhat less out of the ordinary. To study science as method, to consider alternative explanations before reaching conclusions, to perceive the historical development of biology, and first and foremost, to deal with those problems that are involved in improving the conditions of human living—these are the laudable aims which the authors keep steadily in mind. They have written in a clear, readily comprehensible style. They have organized the subject matter into units dealing with Problems of Good Land Use, the Adaptations of Living Things for the Lives They Lead, the Use of Food and Removal of Wastes by the Body, Plant and Animal Behavior, Personal and Social Health, the Development and Improvement of Living Things, the Maintenance of Kind, and the Conservation of Our Biologic Wealth. These units provide a full and coherent survey of pure and applied biology on the high school level, save that sex education and human reproduction are hardly treated adequately for young people, most of whom will never have any more formal training in biology.

Projects, activities, and investigations, and books for supplementary reading are listed along with questions dealing with applications of the facts and principles learned. At the end of the book there is a brief survey of the principal divisions of the plant and animal kingdoms. There is a full glossary and an excellent index.

In sum: a very fine high school textbook.

BENTLEY GLASS

A TEXTBOOK OF GENERAL BIOLOGY. *Third Revised Edition.*

By E. Grace White. The C. V. Mosby Company, St. Louis. $4.50. 659 pp.; ill. 1946.

The chief change in this third edition is the addition of a chapter, Some Problems of Metabolism, which includes discussions of the chemistry of metabolism, activators, enzymes, hormones, vitamins, energy, and bioluminescence. In this chapter para-aminobenzoic acid is omitted from the group of B vitamins, although all the others are considered at length. The close relationships between genes, enzymes, and vitamins are not suggested, but much is made of radioisotopes. The account of mitosis and the figures which illustrate the process remain unsatisfactory.

A tour de force in this textbook is to be found in the treatment it accords organic evolution. The word itself occurs, I believe, only three or four times in the book (it is not listed in the index). Evolution is charitably described as a working hypothesis, and the theory of natural selection is also described as having "great possibilities." The discussion goes on to consider variation, the inheritance of acquired characters, and the mutation theory, but evolution remains conspicuously absent. At the end of the book there is a chapter called Adaptations in Animals, in which much of the customary evidence bearing on evolution is treated. The recapitulation theory, protective adaptations, the geologic ages and fossils, the development (sic) of the horse, and, in the following chapter, phylogenetic relationships, follow without a reference to (or with only a surreptitious hint at) evolution.

This textbook, it appears, fills a definite need. It should fit nicely the requirements of those fundamentalist colleges where the horrible specter of evolution is *never* (or hardly ever) to be admitted.

BENTLEY GLASS

A LABORATORY MANUAL OF GENERAL BIOLOGY. *Third Edition.*

By E. Grace White. The C. V. Mosby Company, St. Louis. $2.00 (paper). 278 pp.; ill. 1946.

Minor changes in terminology, diagrams, and directions have been made to accord with the third edition of the author's *General Biology*. A few experiments have been added.

BIOLOGY: HISTORY AND BIOGRAPHY

SCIENCE PAST AND PRESENT.

By F. Sherwood Taylor. William Heinemann, London and Toronto. 10s. 6d. viii + 275 pp. + 22 plates; ill. 1945.

Few histories of science achieve half so well as this one, even in twice as many pages, the task of portraying the spirit, aims, and methods of science through the centuries. Chief emphasis is given to "the growth, functioning, powers, and limitations of science that the citizen, as distinguished from the scientist, requires to understand . . . how science has influenced philosophy, religion, and the externals of life . . . how and in what ways it can and cannot be used to modify his own environment." Each chapter consists of a well-knit account of a part of the history or method of science, followed by extracts from the classics of science, by way of illustration. The latter, only too brief, add enormously to the interest and effectiveness of the presentation. Perhaps they would be even more effective had they been made an integral part of the running account, but that would, of course, have been a difficult task.

Biologists are likely to conclude that the science of life has been somewhat slighted. The physical sciences, especially in their technological aspects, have fared much better. Only three of the eighteen chapters and some sections of others are given to biology. The relation of science to public health and the emergence of the germ theory of disease, the rise of the theory of organic evolution, and some phases of modern physiology are treated fairly extensively. Genetics is disposed of in a little over a page, which includes erroneous dates for Mendel's work, and the attribution of its rediscovery to Bateson in 1899 (!). Embryology is completely ignored. The names of Linnaeus, Pavlov, Lyell, and many another notable are nowhere to be found. Yet, in spite of such omissions, many of which were certainly necessary in so brief a book, the treatment must be regarded as a stimulating introduction to the subject.

A special word of praise should be said for the thought-provoking final chapters, "What is Science?" and "The Functions of Science."

BENTLEY GLASS

ESQUISSE D'UNE HISTOIRE DE LA BIOLOGIE. *Twelfth Edition.*

By Jean Rostand. Gallimard, Paris. 140 fr. (paper). 257 pp. + 14 plates. 1945.

To our great loss, let it be said at once, there is no book comparable to this in English. Appropriately titled, for it is no full-length history of biology, it takes the form of a series of short sketches of the lives and contributions to science of Redi, Leeuwenhoek, Linnaeus, Buffon, Bonnet, C. F. Wolff, Spallanzani, Lamarck, Etienne Geoffroy Saint-Hilaire, Cuvier, Darwin, Pasteur, Weismann, Brown-Sequard, Mendel, de Vries, and T. H. Morgan. These, however, are not in the least disconnected essays. The theme of the book is the interrelated development of certain of the great

concepts of biology, viz., the formation of the organism and the cell theory, the evolution of species, and the genesis and heredity of life. The individuals selected have been chosen because of their importance in the history of these ideas, and the several accounts of their contributions are connected not only through the direct continuity of ideas, but also by means of special chapters, such as those on the problem of generation, the origins of the cell theory, the chromosomes, and experimental embryology.

Not in its coherence and broad plan alone does this work of Rostand stand out from the usual sort of "lives" book, but also in the profound scholarship and critical faculty which mark each essay. Rostand does much more than get his facts straight; he places them so that their relation to his themes is unmistakable. The book is full of interesting things, many of which will be new at least to English readers—such as the account of the little pantalettes with suspenders in which first Réaumur and afterwards Spallanzani dressed male frogs, in order to find out whether or not they emitted semen in copulation. Yet none of these interesting anecdotes is related for the sake of human interest alone, but always because of its contribution to the principal themes.

Others have discussed the struggles of preformation and epigenesis and the embittered battles of ovists and animalculists in the seventeenth and eighteenth centuries; but no one else has so clearly delineated the relation of both these conflicts to the beliefs and doubts regarding spontaneous generation, heredity, and the transformation of species. No one has been fairer to the real sense of Charles Bonnet's views on preformation, and it is a sole matter of regret that Rostand seems not to have been equally aware of the importance of Maupertuis on the side of epigenesis and the evolution of species. The chapter on Preformation and Epigenesis in the Twentieth Century is a masterly summary of the ultimate concord between these views, so long thought to be irreconcilable, attained in the recognition that life starts with "a germ very potently organized, yet without preformation." This chapter is followed by a penetrating look into the future of biology, and a resumé that clearly underlines the value of knowing the history of your subject.

Rostand's style is fluent, popular, clear. This book, for its content and style equally, may be placed at the head of the books recommended to graduate students in biology working up their French. May we soon have its like in English!

BENTLEY GLASS

GOETHE'S BOTANY: *The Metamorphosis of Plants (1790) and Tobler's Ode to Nature (1782). Chronica Botanica, Volume 10, Number 2. With an introduction and translations by Agnes Arber. The Chronica Botanica Company, Waltham, Massachusetts; G. E. Stechert and Company, New York.* $2.00 (paper). Pp. 63–126 + 3 plates. 1946.

In this number of the *Chronica Botanica*, Agnes Arber has provided biologists with a very fine translation of Goethe's *Versuch die Metamorphose der Pflanzen zu erklären*, of 1790, and has accompanied it with a fairly lengthy interpretative introduction. She has also included the fragment known as *Die Natur*, both in the original tongue and in translation, and some interesting plates and figures, a number of which reproduce drawings by Goethe himself or made under his direction. These pictures, as Agnes Arber says, "bear witness to acute observation and a keen, if selective, insight," and serve to enhance the estimate of Goethe's botanical knowledge based on the *Metamorphose* alone.

Goethe's quest for essential oneness in Nature was the well-spring of his ideas of plant structure, and it led him to see in all plant members expressions of a single form, of which the leaf is the implicit type. His philosophical bias led Goethe to overlook or ignore many aspects of plant structure, but nevertheless also led him to perceive clearly the common relationships of leaves, sepals, petals, stamens, styles and pistils, fruits, and cotyledons. His study of the development of form in the stem-leaves from node to node anticipated such current studies as those of S. G. Stephens (*J. Genetics* 46: 28. 1944; etc.). In spite of the great interest Goethe expressed in the theory of organic evolution in his later years, and the obvious congruity of the concepts developed here with evolutionary ideas, Goethe did not identify himself in the *Metamorphose* as an evolutionist. Nevertheless, the work is an evolutionary foundation-stone that has been of great influence, particularly in the development of botany in Germany. It stands as a nearly unique meeting-point of poetry, philosophy, and science, and must consequently remain of the broadest general interest.

BENTLEY GLASS

THE FIRST HUNDRED YEARS OF THE SMITHSONIAN INSTITUTION, 1846–1946. *By Webster P. True. Smithsonian Institution, Washington D. C.* Gratis (paper). viii + 64 pp. + 41 plates. 1946.

This beautifully illustrated brochure tells how the Smithsonian Institution came to be founded through the bequest of an Englishman who never visited the United States, how it grew under the wise direction of its successive secretaries, Joseph Henry, Spencer Fullerton Baird, Samuel P. Langley, Charles D. Walcott, Charles G. Abbott, and the incumbent, Alexander Wetmore. Chapters are devoted to telling, all too briefly, about the foundation of the Museums, the anthropological

studies of Indian peoples, the studies of solar radiation, the National Zoological Park, the National Gallery and other museums of art, the many expeditions sponsored, paleontological and archeological, the diffusion of knowledge through the wide distribution of publications, and about special wartime activities of the Institution. The summary is that of a record of which the Smithsonian can well be proud. It should call for intensified support of the institution by Congress and the people of the United States.

CHARLES DARWIN AND THE VOYAGE OF THE BEAGLE. *Edited with an introduction by Nora Barlow. Philosophical Library, New York.* $3.75. x + 279 pp. + 15 plates + 1 map. 1946.

The law of diminishing returns makes itself evident in this volume. That is to say, in spite of the care and faithful scholarship expended by Charles Darwin's granddaughter, Lady Barlow, in ferreting out unpublished letters and in deciphering half-illegible notebooks, there is really little here to throw new light on Darwin's life and work. Included are twenty-seven letters entirely or in large part unpublished previously, with eleven already published letters added to make for continuity in the story of the voyage in H. M. S. Beagle. The second part of the volume starts the voyage all over, and again takes one around the world, this time by way of the pocket notebooks in which Darwin jotted down his impressions of what he saw on the spot. Most of these notes were later written into the *Diary* and the *Voyage of the Beagle* in extended and more literary form. There is also a good Introduction by Lady Barlow dealing with Darwin's family and home life, his education, the circumstances leading up to his voyage, and the character of Captain Robert FitzRoy.

The volume is interesting and readable. It will intensify one's appreciation of Charles Darwin's character and the significance of the insights into nature he gained on the voyage. But to those who already know the *Voyage* and the *Diary* and the three volumes of the *Life and Letters*, there will be little here that is new or unexpected. It is mainly a book for special students of Darwin's life.

BENTLEY GLASS

ECOLOGY

FOX SQUIRRELS AND GRAY SQUIRRELS IN ILLINOIS. *Bulletin of the Illinois Natural History Survey, Volume 23, Article 5.*

By Louis G. Brown and Lee E. Yeager. Illinois Natural History Survey, Urbana. Free upon request (paper). Pp. 449–536. 1945.

The main objectives of this study of two species of arboreal squirrels were to determine the environmental requirements, breeding seasons, and related biology as bases for sound game administration and management in Illinois. Field investigations covered a four-year period beginning in 1940, during which intensive as well as extensive methods were used, involving direct observation of free-living populations and post-mortem examination of thousands of specimens. Some information was obtained through a judicious use of questionnaires. Sex ratios, age classes, hours of daily activity, seasonal movements, mortality, pathology, breeding and rearing phenomena, habitat types, nutrition, shelter, and human hunting are among the subjects treated.

The fox squirrel (*Sciurus niger rufiventer*) over the state as a whole was about twice as abundant as the gray squirrel (*S. carolinensis*), inhabiting "most wooded areas, including small woodlots and hedgerows, in every Illinois county. The gray squirrel ... occurs in all Illinois counties except some on the black prairie. It is confined to dense forest stands and is most numerous in those with brushy understory in the river bluffs and bottoms areas." "Little or no competition between fox and gray squirrels was observed," though it must be said that competition manifested by density effects rather than by hostile displays could well exist without being detected in the available data.

Both species have two breeding seasons per year: one in winter and spring, and the other in spring and summer. The spring-summer litters appear to be largely the offspring of vigorous females over 18 months old, and the killing of considerable numbers of females with pregnancies or dependent young is an objectionable accompaniment of the traditional mid-summer shooting. The authors recommend opening the hunting season for squirrels no earlier than September 1 in any part of Illinois. Along with other management measures, it is suggested that den boxes be put out in areas where natural tree cavities are scarce, as in fencerows and hedgerows.

PAUL L. ERRINGTON

TEMPERATURE TOLERANCES IN THE AMERICAN ALLIGATOR AND THEIR BEARING ON THE HABITS, EVOLUTION, AND EXTINCTION OF THE DINOSAURS. *Bulletin of the American Museum of Natural History, Volume 86, Article 7.*

By Edwin H. Colbert, Raymond B. Cowles, and Charles M. Bogert. American Museum of Natural History, New York. 75 cents (paper). Pp. 327–374 + 6 plates. 1946.

This study, which will be of interest to all students of evolution as well as to herpetologists, showed that alligators are much more sensitive to temperatures

above their critical maximum of 38°C. than to temperatures below their optimum (32–35°C.). The ability to withstand injurious temperatures is directly correlated with body size. Young animals are consequently more severely affected by exposure to direct sun. Position (bipedal, quadrupedal off the ground, and quadrupedal prone) was also found to be related to resistance to exposure to the sun, the first position producing highest resistance to over-heating, the third least. The authors are in disagreement as to the significance of these findings for the problem of the extinction of the dinosaurs.

EVOLUTION

THE ORIGIN OF LAND PLANTS *and Four Other Papers. The Johns Hopkins University Studies in Geology, Number 14.*

By Edward W. Berry. The Johns Hopkins Press, Baltimore. $2.50 (paper). 194 pp. + 17 plates, 1 map, and 1 chart. 1945.

The principal essay in this volume, entitled "The Beginnings and History of Land Plants," is the last of a series of publications which Berry has written since 1902. (The four shorter papers included in the volume describe fossil plants from South America, and will not be further considered in this review.) Not since the career of Goeppert in the nineteenth century has a paleobotanist covered so wide a range of interests with such voluminous productivity. As in all of Berry's papers, an admirable command of words and an iconoclastic approach rest upon the sound foundation of his wide knowledge of plants and their geologic history. This final study represents a resumé of many of the ideas and principles which he developed during nearly half a century.

We may pass rapidly over the first half of the essay, in which Berry successfully defends his opinion that the psilopsids of the Devonian do not represent the oldest land plants. Few paleobotanists and not many of the text-book writers, to whom he refers with good-humored irony, have for more than a decade believed that the known examples of these simple and ancient plants are the utltimate ancestors of the Tracheophyta. A discussion of misconceptions based upon too rigid a concept of organology by morphologists, and upon the provincial background of many paleontologists in their study of past climates, leads Berry to conclude that we need new approaches to problems in plant history, of which the status of the Psilopsida is one. His review of Devonian land plants provides a useful summary of this rapidly expanding chapter of plant history.

A similarly enlightening survey of later Paleozoic plants is designed to reinterpret and integrate the often divergent views of the morphologist and historical geologist. Acquisition of the seed habit in the Lycopsida is discussed from the standpoint of function rather than of structure. The development of progressively complex stem tissues is interpreted as resulting from increasing plant size; the simple treatment of this usually obscure subject seems to me to represent the high point in the essay. The orthodox opinion that there was a wide break between the land floras of the Paleozoic and Mesozoic eras is considered and discounted.

In his summary of later land plants, Berry pays his respects to those "pessimists" in systematics who "dodge the responsibility of a name" by assigning to form genera impressions of leaves and other fossils lacking internal structure. He registers well-merited skepticism toward the concept of cosmopolitan distribution. Discussion of the ferns, cycadeoids, and ginkgoids of the Mesozoic precedes his final topic, the ancestry of the angiosperms. The absence of any record of the early ancestors of this group is elaborated, together with a summary of current interpretations of the Caytoniales.

To any reader of his papers published during Berry's life-time, the exceptionally high number of typographical errors in this volume will be convincing indication that he did not read the proof.

RALPH W. CHANEY

FOSSIL PENGUINS. *Publications of the Scarritt Expeditions, Number 33. Bulletin of the American Museum of Natural History, Volume 87, Article 1.*

By George Gaylord Simpson. American Museum of Natural History, New York. $1.20 (paper). 100 pp.; ill. 1946.

This successful excursion by a skilled student of fossil mammals into the realm of paleornithology is due to two factors: first, his discovery in the Patagonian Miocene of the penguin skeleton which forms the basis of his descriptive section and, secondly, it would seem, a wish (here satisfied) to prove that in his American Museum title of "Curator of Fossil Mammals and Birds" the last word is no mere flourish.

Simpson's specimen of *Paraptenodytes antarcticus* is by no means a complete penguin skeleton, but it is by far the closest approach to completeness as yet found in the fossil record—penguin remains found in the past have mainly consisted of isolated bones. Its identification leads him to a systematic review of described fossil penguins and their taxonomy; its description to a study of the comparative osteology of fossil (and recent) penguins. All fossil (as recent) forms are from the Southern Hemisphere: most from Patagonia and Seymour Island, off the South American sector of Antarctica; a few from New Zealand; one from southern Australia. All, or almost all, Tertiary forms are from Miocene deposits. Although the extinct

forms can be included with the living genera in a single family (Spheniscidae), they must be placed in several distinct subfamilies which show to varying degrees features more primitive in nature (in an intra-avian sense), such as a more elongate and more strongly fused tarsometatarsus.

As is well known, some fossil penguins were of considerable size. Some, Simpson estimates, may have been five feet or so tall and, while thus somewhat under human stature, have reached a maximum weight on the order of 200 pounds. In contrast, the largest of living penguins does not exceed 3 feet 6 inches and some 70 pounds.

The problem of the zoological position and origin of the penguins has attracted the attention of numerous authors. Simpson discusses the various theories that have been proposed. He takes, as have other writers, a dim view of the theory most recently advocated by Lowe that the penguins have descended directly and independently from primitive Mesozoic birds which had never acquired the power of flight—a theory which requires many osteological and paleontological improbabilities for its acceptance.

Under a second type of theory, the penguins are supposed to have descended from once-flying birds which had become terrestrial and later took up aquatic life. Matthew once made the interesting suggestion that the penguins formed the Tertiary terrestrial citizenry of Antarctica, but were pushed into the Antarctic seas by increasing cold and advancing ice. To the reviewer's mental satisfaction but heart-felt regret, Simpson has rather adequately demolished this pretty picture.

It may be noted that our conception of the penguins as typically Antarctic birds has little basis in fact. They are, it is true, confined to the Southern Hemisphere (Anatole France's Penguin Island was in the Northern Hemisphere, but his (French) penguins were (English) auks, birds of another nature, if not color). But both fossil and recent penguins are essentially forms of the temperate zone. The fact that a few living forms range into the Antarctic no more justifies us in calling them an Antarctic group than the existence of a Galapagos penguin justifies a claim that penguins are tropical in nature.

Simpson points out structural features in penguins which suggest to him, as to certain earlier workers, a relationship to the Procellariiformes—an order of strong-flying oceanic birds such as the petrels and albatrosses. Certain members of this and other bird groups are capable of using their wings for swimming as well as flying. The penguins, Simpson suggests, are descended from forms of this sort which concentrated on the aquatic side of this amphibious mode of life to such an extent that aerial navigation was finally lost. The wing was never reduced. It never lost its function. The penguin is still, in one sense, a flying bird, but one which flies in the water.

A. S. ROMER

APES, GIANTS, AND MAN.

By Franz Weidenreich. The University of Chicago Press, Chicago. $2.50. viii + 122 pp.; ill. 1946.

The five chapters of this little book are lectures presented by the author at the University of California in 1945, and are titled: Man and his simian ancestry; The development of the specifically human form; Giants as earliest ancestors; The human races: principles of their classification and origin; and Form and qualities of the human brain and skull in the light of evolution.

In chapter I the author outlines his views on man's ancestry and structural relationships with other forms, and gives a brief description of the fossil remains of various monkeys and apes. He begins, and ends, his analysis of man's relationship with the quotation of Thomas Henry Huxley (1863): "Whatever system of organs may be studied, the comparison of their modifications in the ape series leads to one and the same result—that the structural differences which separate man from the gorilla and chimpanzee are not as great as those which separate the gorilla from the lower apes." That this statement is as significant today as it was 83 years ago is a matter of opinion, but it scarcely does justice to the immense amount of work done since Huxley's time. To be told that this statement "settled once and for all, the question of the special place of man in the zoological system," is astonishing enough, but later (p. 46) the author dubs Huxley's conclusion "more or less of a speculation"!

Weidenreich spends much of this chapter pointing out the differences between the great apes and man, and his data lead him to the conclusion (p. 17) that the simian type from which man and the anthropoids branched off showed more of the human organization than of the anthropoid's. This statement implies that the author is in general agreement with those who believe it is yet to be proved that man has passed through an anthropoid stage. Yet in comparing fossil human types with living primates, he restricts himself to the great apes and particularly to the gorilla.

Various human fossil types are described in chapter II, and are divided into three groups, using age and primitiveness as criteria—the Archanthropinae, Paleoanthropinae, and Neoanthropinae. Because of the available material, Sinanthropus was chosen as a standard type of the Archanthropine skull, and is compared with that of modern man. The remainder of the primate order is represented in the comparison only by a female gorilla.

The author's intimate descriptions of the fossil pri-

mate finds in Java and China constitute chapter III. The skull remains of several giant primates are described, and two of them (*Meganthropus* and *Gigantopithecus*) are considered by Weidenreich to be human. The latter genus was twice as large as a male gorilla, if the size of the teeth is a reliable criterion. This chapter contains original and challenging material, and forms the best part of the book. It is regrettable, to this reviewer, that more of the volume was not devoted to a description of this material—to which the author himself has contributed so much.

In chapter IV the author has pointed out the difficulty of satisfactorily defining human races, and the confusion which exists between the so-called racial characteristics and the constitutional types found in all groups of men. He has emphasized that primitive men also showed variation in physical constitution, and thus were not homogeneous groups. Because of the distribution of primitive men over the entire Old World and their resultant interbreeding, the ideas of pure races, then and now, are equally far-fetched. His scepticism toward overly rigid racial definitions is in agreement with many workers in the field. His arguments are inconsistent, however, for a few pages farther on he testifies that three skulls (of a single family—?) taken from a Chinese cave show special affinity to Mongolian, Melanesian, and Eskimo types respectively.

In chapter V, Weidenreich considers the changes undergone by the human brain and skull from the time of most primitive man to the present. The author has described the gradual increase in cranial capacity from *Pithecanthropus* to Neanderthal man, followed by a slight decrease since that time. He points out that the evolution of the brain since Neanderthal times consists of internal organization and greater fissuration, rather than in size changes. The great range of cranial capacity relation to body size in modern man certainly leads one to question the significance of Weidenreich's absolute measurements of fossil forms. It would be misleading, for example, to compare the cranial capacity of certain Cro-Magnon skeletons, which were those of very large men, with that of the average-sized man of today.

Taken as a whole, this is a disappointing book. That it represents a series of lectures might explain its lack of integration. More difficult to understand, however, in view of the author's eminence, is the mixture of original and important work with the quantity of dogma and rather shopworn material, seemingly picked at random from the literature. It adds up to a heterogeneous and, in places, arbitrary collection of anthropological miscellany.

JAMES M. SPRAGUE

UP FROM THE APE. *Revised Edition.* *By Earnest Albert Hooton. The Macmillan Company, New York.* $5.00. xxiv + 788 pp. + 40 plates; ill. 1946.

The first edition of *Up from the Ape* appeared in 1931. It represented something of a novelty in the way of an introduction to the science of physical anthropology, for it was not only comprehensive but eminently readable as well. These same virtues are to be found in the revised, second edition, just fifteen years later. To attempt to cover the entire broad field of physical anthropology is a staggering task for a single individual, even for one as well-informed and versatile as Earnest Hooton. Thus, inevitably, the different sections of the book are uneven in treatment and value. But as a whole the volume is one that, in respect to scope and mode of presentation, is unique among anthropological texts, certainly at least among those written in the English language.

The interval of fifteen years between the two editions has produced striking advances in factual data and in the viewpoint of physical anthropology, so that this new version represents a truly extensive revision. In the judgment of the author, the advance of knowledge has been most marked in the fields of human paleontology, primatology, and the physical anthropology of the individual in relationship to his physiology, psychology and behavior. It is in these sections of the book, therefore, that one finds the most radical alterations from the original edition.

The contents are presented in six parts: I, Man's Relations; II, The Primate Life Cycle; III, The Individual Life Cycle; IV, Fossil Ancestors and Collaterals; V, Heredity and Race; VI, The Anthropology of the Individual. These are followed by a "Bibliography" of 13 pages and a new appendix of 55 pages devoted to the elementary principles of anthropometry. In the opinion of the reviewer, the best parts are those that deal with fossil man (IV) and with human races (V).

Although the differing interpretations of a particular fossil are presented to the reader, Hooton fortunately does not hesitate to give his own diagnosis. Thus it is of interest to note that he does not regard the Australopithecinae as directly ancestral to man, that he accepts the Piltdown cranium and mandible as belonging to one and the same individual, that he apparently aligns himself with those who interpret the Mount Carmel population as the result of race mixture, and that he accepts Swanscombe man as a mid-Pleistocene *Homo sapiens*. Unfortunately, some of the drawings of fossil human skulls—notably that of Rhodesian man (fig. 53, p. 341)—are distorted and hence misleading.

The chapter on race is certainly one of the very best available anywhere. In its authoritative character and rationality it stands in marked contrast to some of the recent hysterical, if well-meaning, outpourings which frantically deny the very existence of biological "race."

Those parts of the book that deal with man's zoolog-

ical affinities and evolution (I, II), although en bloc a good elementary introduction to the subject, are less satisfactory in detail. The author lapses frequently into Lamarckian interpretations of evolutionary change, which, in the light of modern genetics, is like "putting the cart before the horse." In discussing the nature of the probable immediate ancestor of man, he attempts to "hold with the hare but run with the hounds." Thus, after listing some of the evidence bearing on the question "Were Man's Ancestors Arboreal Arm-Swingers or Pronograde Ground Apes?", he concludes that "the most reasonable solution of the problem, as the evidence now stands, lies in a compromise between the two extreme views." But since Hooton conceives these ancestors to have been somewhat generalized, arboreal anthropoid apes, "yet of modern giant primate size," his compromised position can only be maintained by some extremely agile cerebrachiation among the phylogenetic trees. These sections also contain some misleading or questionable statements. Thus, it is highly improbable that the ischial callosities of Old-World monkeys are sensory in function (p. 21). Baboons do not customarily walk flat on their palms (pp. 24, 84). The hand of the gorilla does not resemble that of man more closely than it resembles the hand of any other ape (p. 35). It is Haeckelism of the worst sort to state that in all true vertebrates "the throat is pierced or nearly pierced at some stage of the animal's existence by paired gill slits" (p. 54). Somites are not equivalent to transverse segments of the body (p. 55). The cerebrum does not constitute the larger part of the adult forebrain, but *per contra* the forebrain forms the greater part of the cerebrum (p. 71). It is highly improbable that *Tarsius* is unable to move its eyes (p. 79). The abdominal viscera of man and the anthropoid apes are not "suspended" from the head end of the body in the manner suggested by the author (pp. 87–88, 133).

The section devoted to "The Individual Life Cycle" (III) includes some archaic embryology and some more incorrect statements. It is misleading to say that the "gill arches" (how one squirms at that term!) of the human embryo are "fishy reminiscences" (p. 214, and similarly on pp. 221–222). There are not *three* "forerunners of the kidneys" (p. 217). The account of the fetal circulation is confused (p. 218). It is a distinct strain on the imagination to interpret the lanugo in terms of ontogenetic recapitulation (p. 223). There is no longer any justification for regarding the vermiform appendix as a vestigial structure (p. 224). Despite what Keith has claimed, the biceps brachii muscle of gibbons does not usually have two or three extra heads (p. 226). It is more than questionable that the relatively great length of the arms in the human fetus and infant is "an anthropoid reminiscence" (p. 238).

The list of literature is no "Bibliography" at all, and in view of the fact that it will be largely used by beginning students, its incompleteness is to be regretted. Furthermore, some of the work referred to in the text is not included.

Yet the omissions and commissions become dwarfed in importance when one considers the really fine service done by Earnest Hooton for physical anthropology when he first produced and later revised this book. It is without a peer in its field, and teaching of the science would be much the poorer without it.

WILLIAM L. STRAUS, JR.

GENETICS AND CYTOLOGY

AN INTRODUCTION TO MATHEMATICAL GENETICS. *By Lancelot Hogben. W. W. Norton & Company, New York.* $5.00. xii + 260 pp. 1946.

Mathematical genetics is a term which might be interpreted in widely different ways. Geneticists often have occasion to use the ordinary statistical methods in describing the populations with which they deal and in testing the significance of differences. The author very properly excludes all of this, except for cases of peculiar interest to geneticists. Significance tests for Mendelian ratios are discussed in Appendix One, which includes a derivation of the normal probability curve and discussion of the probability integral. Appendix Two deals at some length with the estimation of linkage and determination of variance formulas for gene frequency analysis by the method of maximum likelihood.

The body of the book deals with the genetic properties of simple populations. Genetics provides as satisfactory illustrations of the principles of a priori probability as do the traditional coins, dice, and decks of cards. The application of elementary probability theory to the interpretation of Mendelian ratios is presented at some length in the first chapter.

This chapter also gives definitions of the principal terms used in connection with populations that are under less rigorous control than the progenies of parents of known genotypes. Definitions are very important here, since the frequent use of popular terms in more or less different technical senses is a source of much confusion. Thus the author's "genetical structure" must not be confused with "breeding structure" or "population structure" of others. Two populations are stated to have the same genetical structure when (a) each consists of the same set of genotypes and (b) the frequencies of the same genotypes are the same. A criticism may be made here that in populations with moderate frequencies of more than one allele at each of a moderately large number of loci, there is little chance for any genotype to appear twice even within the life of the species. The reviewer would prefer to put the emphasis on the more stable system of gene frequencies, in combination with an adequate statistical description of the breeding structure.

Systems of mating are classified primarily as non-assortative and assortative. The former is equivalent to what most geneticists have called random mating. Hogben holds that the latter practice is misleading. He considers that all systems of mating must be considered as random in which there is randomness of mating within subgroups. This would seem to warrant the description of a deck of cards in which the suits are assembled, as having a random distribution provided that there is adequate shuffling within the suits. Assortative mating is divided into two categories: familial assortative mating, or inbreeding, and phenotypic assortative mating. Most authors have restricted the term assortative mating to the latter.

Chapters 2 to 4 are almost purely mathematical. They deal with the properties of algebraic series and the elements of the calculus of finite differences. The binomial series is given special treatment in chapter 4. The remaining chapters apply this mathematics to non-assortative mating in the absence of selection or mutation (chapter 5), selection (chapter 6), assortative mating and consanguinity (chapter 7), and mutation pressure and isolation effects (chapter 8).

The mathematical method used is a straightforward and valuable one. It is, however, rather cumbersome, and perhaps for this reason the treatment is largely restricted to problems involving only one pair of alleles. Even these steps in the reasoning, while easy, are often so numerous that by the end of the climb insight is likely to be lost.

This may be illustrated by the discussion of the equilibrium reached by sex-linked alleles under non-assortative mating and the mode of approach to this equilibrium. The treatment is in terms of the genotypic frequencies DD, DR, and RR in females, DY and RY in males. Subscripts indicate generations. After considerable algebra here and reference to the mathematics of a recurrent series presented at length in earlier chapters, the author arrives at the following conclusions:

$$RY_n = (1/3)\,(RY_0 + 2RY_1) + (2/3)\,(RY_0 - RY_1)\,(-1/2)^n$$

$$DY_n = 1 - RY_n$$

$$RR_n = RY_n \cdot RY_{n-1}$$

$$RD_n = 2(RY_{n+1} - RR_n)$$

$$DD_n = 1 - RR_n - RD_n$$

It is pointed out that RY_n oscillates about its limiting value $RY_\infty = (1/3)\,(RY_0 + 2RY)$ and that $RR_\infty = (RY_\infty)^2$.

It seems simpler to reduce the whole matter to one of gene frequencies. Letting q_f and q_m be the frequencies of an allele in females and males respectively, and q'_f and q'_m the values in the preceding generation, the facts that males receive their X chromosome only from their mothers, and that females receive theirs equally from both parents can be stated in the equations:

$$q_m = q'_f$$

$$q_f = (1/2\,(q'_f + q'_m)$$

Since every individual has an equal number of female and male ancestors of each generation, and since the former carry twice as many X chromosomes as the latter, it is fairly obvious that the effective mean gene frequency is $\bar{q} = (1/3\,(2q_f + q_m)$. It is merely a matter of substitution of the above values for q_f and $_m$ to show that $\bar{q}$ is constant ($\bar{q} = (1/3)\,(2q_f + q_m) = (1/3)\,(2q'_f + q'_m)$) and that a deviation from this in either sex is followed by a deviation half as great and in the opposite direction in the next generation.

$$(q_f - \bar{q}) = 1/2\,(q'_f - \bar{q})$$

$$(q_m - \bar{q}) = -1/2\,(q'_m - \bar{q})$$

The values for any generation follow at once.

$$(q_f - \bar{q})_n = (-1/2)^n (q - \bar{q})_0 \text{ etc.}$$

The array of genotypic frequencies in any generation can, of course, be obtained as the product of the frequency arrays for eggs and sperms $[q_f R + (1-q_f)D]\,[(1/2)q_m R + (1/2)\,(1-q_m)D + (1/2)\,Y]$, still assuming non-assortative mating and using R, D, and Y here for the genes (or chromosomes) themselves, rather than for their frequencies.

The important subject of the equilibrium established among genotypic frequencies involving two (or more) possibly linked loci is not discussed, which is unfortunate, since this matter (discussed by Weinberg in 1909 and Robbins in 1918) is still often misunderstood. There is also no mathematical discussion of quantitative variability dependent on multiple genetic and non-genetic factors. The consequent restriction of the treatment of selection and phenotypic assortative mating to single loci omits the most interesting aspects of these processes. The treatment of inbreeding is restricted to such simple cases as self-fertilization, parent-offspring mating, brother-sister mating and sporadic mating of first cousins. Adequate discussion of human races and of other natural populations and of breeds of livestock requires a more general approach. Here again the limitation of the treatment seems to be due to the relative cumbersomeness of the mathematical method that is used. Finally, there is no discussion of the distribution of gene frequencies resulting from simultaneous effects of the various evolutionary pressures and the effects of accidents of sampling.

Summing up, the book gives a good introduction to the use of the elementary theory of probability and of the calculus of differences in determining the frequencies of alleles in simple populations under various conditions; but it does not penetrate far into the problem that must be considered in dealing with complex characters in populations with the complexity of structure encountered in nature, in human races, or even in breeds of livestock.

SEWALL WRIGHT

GÉNÉTIQUE ET HÉRÉDITÉ. *"Que sais-je?" Le point des connaissances actuelles. Number 113.*

By Maurice Caullery. Presses Universitaires de France, Paris. 45 fr. (paper). 128 pp. 1943.

This short volume comprises an admirably condensed review of genetics suitable for college teachers of the subject. The author begins with a brief consideration of fertilization, mitosis, and meiosis. Cytological theories of crossing over are not presented in detail. The fundamental laws of genetics are introduced from the historical point of view, the work of Sageret and Naudin being considered prior to that of Mendel. Three chapters are devoted to the essential features of *Drosophila* genetics, i.e., to linkage maps, sex determination and sex differentiation, non-disjunction, attached-X females, giant salivary gland chromosomes, and a mention of translocations, inversions, duplications, and deficiencies. A chapter on the experimental production of mutations includes Muller's famous ClB method and a discussion of the effect of X-rays on the induction of both direct and inverse mutation. An excellent review of the work of Ephrussi and Beadle on eye pigmentation in *Drosophila* is given in the chapter on genic action. Two short chapters follow which are devoted to interspecific hybridization and maternal effects, respectively. The final chapter includes a survey of human heredity: work on identical and fraternal twins, A B O blood groups, and traits dependent upon autosomal dominant or recessive genes, or sex-linked recessive genes. In describing the inheritance of the blood groups, the author presents the theory of von Dungern and Hirzfeld that two pairs of allelic genes are responsible; the more commonly accepted multiple allele theory of Bernstein being given in a footnote along with a brief consideration of inheritance of the M N blood types. A bibliography of 19 references concludes the book.

SARAH BEDICHEK PIPKIN

HOW HEREDITY BUILDS OUR LIVES: *An Introduction to Human Genetics and Eugenics.*

By Robert Cook and Barbara S. Burks, with drawings by Clyde E. Keeler. American Genetic Association, Washington, D. C. 75 cents; $5.00 per dozen (paper). 64 pp.; ill. 1946.

How Heredity Builds Our Lives is an excellent account of the differentiation of human traits through the interaction of heredity and environment. Although the work is written from the popular point of view, it is a veritable gold mine for the teacher of heredity. The numerous fine illustrations include both drawings and photographs. The first chapter, entitled "Living Building Blocks," outlines the basic principles of heredity. Chapter 2, entitled "Unravelling Heredity and Environment," points out the contributions of both heredity and environment to the differentiation of human traits in a clear manner rarely met with in other accounts of the same subject. Chapter 3, or "What Environment Can Do," is followed by a discussion of "Eugenics." The book is concluded with a list of 21 references to other works on human heredity.

SARAH BEDICHEK PIPKIN

ELEMENTS OF GENETICS: *Mendel's Laws of Heredity with Special Application to Man. Second Edition.*

By Edward C. Colin. The Blakiston Company, Philadelphia and Toronto. $3.50. xiv + 402 pp.; ill. 1946.

The second edition of this textbook has been improved and brought up to date by a number of additions, which include discussions of the binomial theorem and the use of the Chi Square Test, the MN and Rh blood groups (the latter already out of date), the analogies between genes and viruses, and position effects. What is, for an elementary textbook, a rather lengthy account of the unsuccessful efforts to induce mutations by means of chemicals is vitiated by the more recent successful attempts, using N and S mustards or phenol. Linkage is now deferred to a later place in the book. The chapters on sex determination, sex differentiation, and sex linkage, and on heredity and evolution show most revision. Many new illustrations and examples have been added throughout.

As a whole, the book has been considerably strengthened, and it should serve particularly well as a textbook for students planning a medical career. As a general introduction to genetics, it still seems biased by overemphasis on man; although, regarded as a strictly human genetics textbook, it perhaps does not go far enough. But the treatment is clear and accurate, and largely free from controversial opinions, so that the book should be widely favored.

BENTLEY GLASS

L'HÉRÉDITÉ. *Third Edition. Encyclopédie Scientifique. Bibliothèque de Biologie Générale.*

By Emile Guyénot. G. Doin & Cie., Paris. 270 fr. (paper). 717 pp.; ill. 1942.

The third edition of Guyénot's *L'Hérédité* represents an enormous enlargement of the earlier editions. It can no longer be regarded as an eminently suitable introduction to genetics, but begins to be a compendium for advanced students. Yet if this is the author's present aim, it would seem that much of the elementary discussion of Mendel's laws, etc., might be omitted, and the book reduced to more manageable proportions. As an up to date summary of advanced genetics, the book suffers unavoidably from the isolation of the author

during the war, so that many important recent advances, such as the studies of biochemical mutations in *Neurospora* and other organisms, of mutations in viruses and bacteria, of species differences in blood proteins in doves and pigeons, and the like, are missing. The book is likely to be most useful for its thoughtful introduction, for the general grasp of the subject shown by the author, and for the broad coverage of the field, particularly *Drosophila* genetics, prior to 1940.

BENTLEY GLASS

HEREDITY, RACE, AND SOCIETY. *Pelican Books.*
By L. C. Dunn and Th. Dobzhansky. Penguin Books, New York. 25 cents (paper). 117 pp. 1946.

This little book is outstanding for the clarity and simplicity of its exposition. It includes only five chapters. These deal with Human Differences, Nature and Nurture, the Method of Heredity, Group Differences and Group Heredity, and Race. In appendixes following chapters III and IV there are somewhat more technical, but still superbly clear, treatments of the evidence for Mendel's Law and the constancy in the proportions of dominant and recessive genes in a population from generation to generation.

The first three chapters deal with subjects often discussed previously in books for the general public, but the last two subjects have not been treated so well on this level before. The distinction between population genetics and Mendelian inheritance is made forcefully. The authors have not been afraid to express their own views, growing out of their understanding of population genetics, on such subjects as the difficulties of eugenics, evolution and "social Darwinism," and the effects of intermarriage. Not all geneticists will agree with them in every opinion—though the reviewer happens to—but certainly these views have every reason to be presented. The effectiveness of negative eugenic measures may not be so low that they should be discarded altogether, even for a century or so, but they are certainly so low that the advisability of applying them is much more controversial than is generally realized, and people ought to know that.

The chapter on Race states in a forthright way the genetic point of view. Races are first defined as "populations which differ in the frequencies of some gene or genes." If this were to be taken literally, it would mean that every population was a race, since it is most unlikely that any two populations could ever be found with identical gene frequencies for all genes. Some criterion of the number or degree of differences in gene frequencies is also needed—and it is precisely here that the subjective element creeps in. The authors recognize this, of course, and later deal with it in as satisfactory a manner as appears possible, in their discussion of race boundaries. Their final words well deserve quotation:

"In the realm of culture there is enough room to accomodate the diversified contributions not only of different individuals but also of every nation and race. It is a waste of time to discuss which particular contributions are superior and which inferior. There is no common measure applicable to the works of a poet, an artist, a philosopher, a scientist, and the simple kindness of heart of a plain man. Humanity needs them all."

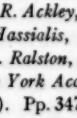
BENTLEY GLASS

GENERAL PHYSIOLOGY

SURFACE ACTIVE AGENTS. *Annals of the New York Academy of Sciences, Volume XLVI, Article 6.*
By M. L. Anson, R. R. Ackley, Earl K. Fischer, David M. Gans, M. H. Hassialis, Rollin D. Hotchkiss, Donald Price, A. W. Ralston, Leo Shedlovsky, and E. I. Valko. The New York Academy of Sciences, New York. $2.25 (paper). Pp. 347–530 + 1 plate. 1946.

The increasing importance attached to the cell surface in development as well as in general physiology makes this little volume especially timely. Presented before the Conference on Surface Active Agents held by the New York Academy of Sciences in 1945, the eight papers are concerned chiefly with water soluble substances that lower the surface tension of water in small concentrations. Those of most interest to biologists include: The Structure and Properties of Solutions of Colloidal Electrolytes, by A. W. Ralston; Surface Active Agents at Interfaces, by E. K. Fischer and D. M. Gans; Certain Aspects of the Chemistry of Surface Active Agents, by Donald Price; Surface Active Agents in Biology and Medicine, by E. I. Valko; and The Nature of the Bactericidal Action of Surface Active Agents, by R. D. Hotchkiss.

GAIRDNER MOMENT



THE LIFE ENERGY OF SPECIES.
By Harold Alexander Danne. Harold A. Danne Engineering Laboratory, New York. $2.00. 27 pp. + 3 charts. 1944.

This brief little book, written by a New York engineer, is full of conclusions, but it is very difficult to read. The gist of it appears to be that different species have different Specific Energies, defined as Time Energy Units per 100 mg. of substance of the species, ionized and measured by Danne's special Apparatus (see figures!). These Specific Energies are in some way related to the content of moisture (Hydrol) in the substance. Measurements and charts of the Vital Time-Energy Units therefore identify species (no need for ordinary taxonomy), pre-

dict life expectancy, and describe adaptation to climate. A few quotations should make this clear:

"Life and existence are a combination of unnumbered and uninvestigated Time-Energy Units all reducible and measurable by the Primary Time-energy Tube illustrated and described here."

"It was found that moisture (the hydrols) had a controlling influence in the structure of the species involved and that the facts derived from the experiments depended on the degree of fractionization and ionization done. . . .

"It has been found that Time Period Bases used as components of the Patterns evolved during the research, develop as straight lines, arcs, parabolas, flattened or distorted, according to the characteristics of the Species tested. . . .

"In animal products, as wool, these bases control the patterns and indicate whether the sample is from pure or crossbred animals, and many other characteristics.

"In vegetable products, as rubber, cotton and oil, these bases control the patterns they produce and indicate the country and parentage of the seed or plant involved. . . .

"The Law of the Composition of Species states this as follows: 'In any equation, where qualities and quantities are expressed in terms of the same groups of fundamental units, the value of the constant is independent of the units used and depends entirely on the qualities and quantities in the fundamental combinations of the units'. . . .

"Botanical identification by sex, color, shape and other superficial peculiarities is therefore superseded."

". . . without the product of Time and Energy there is nothing. Uncounted trillions of these Units are not idle but are perpetually active, whether they are in the animal, mineral or vegetable world. . . .

"Life and existence are automatic functions of these Units. Other action of these Units is called Willpower, Initiative, and Spirit. . . .

"They are the epitome of all being, even as You and I."

A fuller account of these astounding discoveries is eagerly awaited.

BENTLEY GLASS

GENERAL AND SYSTEMATIC BOTANY

MERRILLEANA: *A Selection from the General Writings of Elmer Drew Merrill. Chronica Botanica, Volume 10, Number 3/4.*

The Chronica Botanica Company, Waltham, Massachusetts; G. E. Stechert and Company, New York. $4.00 (paper). Pp. 127–394. 1946.

An authorized selection from the extensive and notable eneral writings and essays of one of the foremost of American plant taxonomists—very carefully prepared by the editors of Chronica Botanica as a fitting tribute to their distinguished co-editor on the occasion of his seventieth birthday anniversary. As admirably stated in the editor's foreword, E. D. Merrill—in the course of his very active career as investigator, writer, and administrator—has been the author of a large number of discussions and essays of a broad general nature and of permanent interest scattered through numerous publications, many of his essays masterpieces in brevity, succinctness, and scholarly treatment of the subject matter.

Among articles selected from an extensive list of publications for inclusion in this volume are: The Ascent of Mount Halcon; Amboina Floristic Problems in Relation to the Early Work of Rumphius; excerpts from A Bibliographic Enumeration of Bornean Plants; Die Pflanzengeographische Scheidung von Formosa und den Philippinen; An Appeal for Simplified Literature Citations; On Correlation of the Indicated Biologic Alliances of the Philippines with The Geologic History of Malaysia; Leprosy Bows to Science; One-Name Periodicals; On Loureiro's "Flora Cochinchinensis"; Scuttling Atlantis and Mu; Palisot de Beauvois as an Overlooked American Botanist; On the Technique of Inserting Published Data in the Herbarium; Domesticated Plants in Relation to The Diffusion of Culture; Man's Influence on the Vegetation of Polynesia, with special reference to Introduced Species; Some Economic Aspects of Taxonomy; Rafinesque's Publications From the Standpoint of World Botany; In Defense of the Validity of William Bartram's Binomials. The book also includes a "Vita" and "Bibliographia" as well as certain portraits, in particular a recent portrait of E. D. Merrill in a very characteristic pose in the midst of the herbarium collections of the Arnold Arboretum. Altogether, this is a distinguished and commendable effort for which great thanks are due the editors of Chronica Botanica.

LADEMA M. LANGDON

LABORATORY EXERCISES: BIOLOGY OF PLANTS.

By H. L. Dean. William C. Brown Company, Dubuque, Iowa. $1.75 (for looseleaf notebook). iv + 244 pp. 1944.

Laboratory Exercises in the Biology of Plants, the outgrowth of a series of manuals and work sheets developed and used during the past several years in the department of botany at the State University of Iowa, is a workbook designed to cover the laboratory studies of a well-rounded year course in General Botany. There are forty-seven exercises: the first twenty-three emphasize the physiology, structure, and ecology of the higher plants; the remaining twenty-four, the structure and reproduction of representative types selected from each of the major plant groups, with exercises in hybrid-

ization, greenhouse observation, and plant propagation. Among unique and particularly commendable features observed in this manual are: (1) its splendid keys, including a key to the Genera of Common Trees, a key to the identification of the more Important Starches, a key to Common Woods, and one to Genera of Common Ferns; and (2) very carefully prepared report guides for field studies.

The manual is well illustrated with original drawings, charts, and diagrams, all of which are large and clear. The reviewer would make one recommendation, that there should be a larger number of drawings to be completed by the student both as to delineation and labeling. The references and thought questions concluding each topic are adequate in number and well selected.

LADEMA M. LANGDON

FLOWERS.

By William Alphonso Murrill. Published by the author, University of Florida, Gainesville. $3.00 (paper). 120 pp.; ill. 1946.

FERNS.

By William Alphonso Murrill. Published by the author, University of Florida, Gainesville. $2.40 (paper). 96 pp.; ill. 1947.

These two little books are additions to the series of "Illustrated Guides" written and published in recent years by W. A. Murrill. They are hardly "Guides" to flowers and ferns in the ordinary sense of the word, but are rambling essays on a variety of botanical subjects, the material for which the author has gleaned from his long and active life. They are filled with accounts of personal experiences and philosophical ruminations. Each of the present booklets begins with a somewhat sentimental story, several chapters long, giving the life histories of people who have made the science of botany a major part of their careers. These are presumably fictional.

In the book on flowers there are chapters on "Familiar flowers," "Virginia spring flowers," "Honey and honey plants" (this chapter contains also, for some reason, a section on "Some edible roots"), "Poisonous weeds," "An ideal life" (a brief description of the author's home and some of his travels between Virginia and Florida; here, also, is a description of some southern pitcher plants), "Florida spring, summer, and autumn flowers," "Alachua orchids" (with keys and brief descriptions), and finally "The mints of Alachua County, Florida" (keys and descriptions). Appended to this volume are short essays on the "Scope of botany," "Historical plants," "The importance of botany," "The classification of plants," and "The geological history of plants." Buried among these essays is a chapter on the "Distribution of certain phanerogams in Florida." From a scientific standpoint I suspect this may be the most significant part of the book. Three groups of species are discussed: first, pairs of species distinguished by habitat; second, species of wide ecological amplitude; and third, species offering unsolved problems of distribution. Students of taxonomy and plant geography will find some food for thought in these notes.

The book on ferns, though nothing is said about them in the title, also contains matter pertaining to mosses, liverworts, and algae. Under ferns are, first, a list of some Virginia ferns, then keys and descriptions of "Northeastern ferns." Presumably this is to cover northeastern United States and adjacent Canada. Some horsetails, lycopods, selaginellas, and *Isoetes* are included in the descriptions, but appear in the keys only in a brief classification according to habitat. Another chapter contains keys to the southeastern species of the Polypodiaceae, Hymenophyllaceae, and Ophioglossaceae, and another has keys to the ferns and fern allies of Alachua County, Florida, and descriptions of some southern Florida ferns.

The final part of the fern book is devoted to "Primitive green plants," with lists of the mosses and liverworts of Alachua County, Florida. There is a short essay on the algae, a glossary of botanical terms, a list of reference works, and an index to the portion on ferns.

Both books are profusely illustrated with photographs and line drawings.

HUGH M. RAUP

POPULUS BALSAMIFERA OF LINNAEUS NOT A NOMEN AMBIGUUM. *Contributions de l'Institut Botanique de l'Université de Montréal, Number 59.*

By Ernest Rouleau. Institut Botanique, Université de Montréal, Montréal. 25 cents (paper). Pp. 103–110. 1946.

ECONOMIC BOTANY

GARDEN LILIES.

By Alan and Esther Macneil. Oxford University Press, New York. $3.50. xiv + 226 pp. + 32 plates. 1946.

A recent addition to the rapidly growing list of monographs on ornamental genera, this readable book on lilies and lily culture should appeal to garden lovers everywhere. The authors are specialists in the field and now share their knowledge with others.

While this handbook is not a compendium of all available data on the subject it is full of factual information and so clearly expressed and beautifully illustrated that the rankest amateur should feel encouraged to try his own hand at lily culture.

The book presents pertinent data on all phases of the

subject, emphasizing especially the usual every-day situations, from the planning of the garden, and selection and ordering of the bulbs, to the actual planting and cultivation. Special problems are also discussed and these are likewise viewed through the eyes of the gardener.

A list of chapters in Part I will give an idea of the scope of the work: geographic sources of origin; the bases of selection; placement suggestions (two chapters devoted to problems which are often the causes of failure); notes on color; planting; culture and propagation; lilies for pots and exhibition (for those with specialized interests); natural hazards and pests; diseases; and lilies through the ages (an historical account).

Part II comprises a descriptive list, with cultural data, of all the lilies of interest to the gardener. A brief taxonomic account of the genus and a glossary of terms are appended, together with a selected bibliography.

ALBERT F. HILL

ÉTUDES ETHNOBOTANIQUES QUÉBÉCOISES. *Contributions de l'Institut Botanique de l'Université de Montréal, Number 55.*

By Jacques Rousseau and Marcel Raymond. Institut Botanique, Université de Montréal, Montréal. $1.25 (paper). 154 pp. 1945.

There are three studies in this work: the botanical folklore of Caughnawaga; the botanical folklore of Ile-aux-Coudres; and ethnobotanical notes on the Tête-de-Boule of Manouan. The first two are by Jacques Rousseau, the last by Marcel Raymond. These are not the frequently met simple lists of plants and their uses, but are more broadly conceived ethnobotanies.

Caughnawaga is a Mohawk (one of the Iroquois tribes) reservation near Montreal. Rousseau gathered data there in 1932 from an old Indian woman. He was aided by a young Iroquois, then a student in college. The botanical notions of the Mohawks are discussed, and the logic of their classification is noted. The materials are then classified by usage: for food, basketry, utensils, clothing, dyes, etc. A separate section is given to a similar medical classification: respiratory, circulatory, eye-, ear-medicines, etc. Instead of stopping at this point, Rousseau then adds comparative notes on medical usage among neighboring and distant peoples. Comparisons are also made with early and modern European materia medica. In this way a thoughtful discussion is carried on that is very enlightening as to the efficacy of the medical materials and as to the thought processes involved in primitive herb usage. The plant names are then studied and arranged according to the manner of naming. Nearly half have proper names and are thought to be species anciently known, while those with descriptive names tend to be introduced plants. Finally, the plants are arranged according to our botanical system and each is briefly discussed. It is regrettable that Rousseau largely disregarded the agricultural plants.

The Ile-aux-Coudres is in the Saint Lawrence River, northeast of Quebec. It was settled almost two hundred years ago and has long been a land of emigration, and untouched by tourists. Hence it retains much of the original folklore of the French Canadians who settled it. Rousseau gathered plant materials and notes on their usage. The treatment follows the pattern of the previous paper, but is less full because of less original and comparative material. Medical material, various useful plants, and a discussion of plant names are each separately presented. There is then a systematic treatment of the material. One of the most interesting sections is the discussion of the importance of seaweed for soil enrichment.

Marcel Raymond's notes on the ethnobotany of the Tête-de-Boule, who live on the Saint Maurice River west of Quebec, were collected in 1940. He describes briefly their life: dwellings, customs, dress, and the tendency for the young people to become assimilated into the Canadian population. The useful plants are then arranged systematically, the scientific name, common name, and Indian name being given for each. The use for each is then given, and historical or comparative ethnological notes are included. Several pages are devoted to the role of the birch (*Betula papyrifera*) in this society. The emphasis is well placed, for this is nearly a birchbark society.

GEORGE F. CARTER

PLANTS AND BEEKEEPING: *An account of those plants, wild and cultivated, of value to the hive bee, and for honey production in the British Isles.*

By F. N. Howes. Faber and Faber, London. 12s. 6d. 224 pp. + 32 plates. 1945.

For many years the amateur and professional beekeepers in the United States have not had available any adequate modern reference work. Now, coincident with a marked increase of interest in beekeeping and the production of honey, there appears a comprehensive work dealing with the bee plants of the British Isles.

Written by a man with long experience in beekeeping, who is also a member of the staff of the Royal Botanic Garden at Kew, this book with its pleasing style, its excellent pictures, and avoidance of technical terms should appeal to the general reader as well as to the specialist in beekeeping. The great majority of the wild and cultivated plants of value to the hive bee and for honey purposes in Great Britain are equally familiar in the United States, and consequently this book should be fully as useful in this country.

Section I is devoted to subjects of general interest,

such as: nectar and nectar secretion; honey in relation to nectar; source; notes on unpalatable and poisonous honey; pollen; the hive bee and pollination; artificial bee pasturage or planting for bees; garden flowers and the honey bee; bee gardens; apiary hedges and windbreaks; honey dew and propolis.

In Section II the major honey plants are discussed in great detail. Included among them are clover, linden, apples, pears, plums, cherries, mustard, hawthorn, blackberries, beans, buckwheat, dandelion, and, surprisingly, the fireweed or great willow herb, *Epilobium angustifolium*.

Section III treats more briefly of 362 other sources of honey, many of them familiar garden flowers. A bibliography and full index are appended.

ALBERT F. HILL

FORESTS AND FORESTRY IN GREAT BRITAIN.

By William Ling Taylor. Crosby Lockwood & Son, London. 12s. 6d. x + 172 pp. + 21 plates. 1946.

Modern war with its insatiable demands on natural resources has brought into ever sharper focus the tremendous importance of forests and forestry in the economy of a country. This has been particularly true in Great Britain, where the realization is growing that something substantial must be done to provide forest resources *within the country* if the safety of that island realm is to be ensured. To quote the author, "There is no indication that a nation in arms will ever be completely safe without unhindered access to forests, and forest products cannot be guaranteed to an island nation from without, as recent events have twice effectively demonstrated; moreover, substitutes for wood, as a raw material, are scarce and unsatisfactory."

Quite evidently the objective of *Forests and Forestry in Great Britain* is to stimulate and broaden interest in forests among the British people and to acquaint them with the bearing that national forest policy has on national welfare. If the book receives the wide distribution and reading that it deserves, this dual objective should be realized.

From the standpoint of the American reader the value of this book lies, first, in that it presents a clear picture of the present state and future possibilities of British forests; and, second, in that it contains a very readable account of what forestry is—how forests are established, cared for, and harvested. The many services rendered by forests, in addition to serving as sources of wood in its various forms, are interestingly and adequately set forth.

Numerous excellent full-page plates illustrate the text of this most useful book.

H. J. LUTZ

GENERAL AND SYSTEMATIC ZOOLOGY

PRINCIPLES OF ANIMAL BIOLOGY. *Sixth Edition. McGraw-Hill Publications in the Zoological Sciences. By A. Franklin Shull, with the collaboration of George R. Larue and Alexander G. Ruthven. McGraw-Hill Book Company, New York and London.* $4.00. xii + 425 pp.; ill. 1946.

The new edition introduces no radical changes in the plan of this oldest and best-known of those zoology textbooks devoted to the teaching of principles rather than to a survey of animal types (cf. Q. R. B. 16: 492. 1941). Many minor changes, such as the reinsertion of the two topics on sex linkage and autosomal linkage in the discussion of genetics, the fuller treatment of historical zoogeography, and the added emphasis given to the study of function in the topics on enzymes, oxidations, muscle action, etc., have been made.

LABORATORY GUIDE FOR ANIMAL BIOLOGY.

By A. M. Elliott. Burgess Publishing Company, Minneapolis. $2.75 (paper). iv + 274 pp.; ill. 1946.

This manual seems certain to make a hit with students, and legitimately, because the 45 full-page figures are unmatched in clarity, completeness, and sheer dramatic appeal. The nematocysts of *Gonionemus* actually look dangerous. The boy-dog-tapeworm-flea cycle, and the pregnant pig, which cuts one of the smartest figures in the book, cannot fail to stick in the memory. The style of the illustrations is like that of Buchsbaum in his *Animals Without Backbones*. In fact, some of them appear to have been redrawn from Buchsbaum with slight improvements—and that is high praise indeed. With each exercise there are ample blanks for the student's own drawings and notations.

The text is clear and maintains a high standard of accuracy. The written questions generally escape the inanity so often found in laboratory manual "thought" questions. Although the present reviewer originated the polyvinyl alcohol technique for quieting *Paramecium* recommended in this manual, he is now convinced that a combination of Buck's Congo red yeast method with a plastic is superior for general teaching purposes. Nor would he admit that the tapeworm is "truly the most degenerate of all animals" or that the second maturation division is "ordinary mitosis." But such blemishes are rare in what is undoubtedly one of the best manuals of its kind available. The treatment is competent, orthodox, and almost entirely anatomical. Included are representatives of all the important phyla from the protozoa "up" through amphioxus, petromyzon, shark, perch, frog (32 pages), and fetal pig. There are several exercises on development and on histology, the latter showing the relation of cells to tissues

to organs after the deservedly renowned style of Fritz Kahn.

GAIRDNER MOMENT

THE TREMATODA *With Special Reference to British and Other European Forms.*

By Ben Dawes. Cambridge, at the University Press; The Macmillan Company, New York. $10.50. xvi + 644 pp.; ill. 1946.

This is the kind of book that will be greatly welcomed and appreciated by zoologists, for it gives detailed and authoritative information about an important group of animals. At present there are very few such accounts of invertebrates available—Stephenson's *The Oligochaeta* and Chitwood's *Introduction to Nematology* are the only ones that come to mind apart from works on protozoology and insects—and the zoologist who wishes to know something more about some group of invertebrates than is to be found in the usual textbook must either consult the large German treatises, available only in large libraries, or laboriously track down special articles in journals. It is to be hoped that the above volume will be the forerunner of similar works by specialists.

The greater part of the book is taken up with taxonomic matters, chiefly keys to the families and genera and descriptions of species of British and European trematodes. The author commendably makes a separate order of the aspidogastrids; but for the Digenea he accepts the division into the suborders Gasterostomata and Prosostomata, a division that has been the object of recent criticism and that probably will not stand. Of greater interest to the general zoologist are the first few chapters, which deal with morphology and sample life histories (unfortunately, our old friend, the liver fluke, is held up as representative of digenetic cycles), and especially the later chapters. The chapter devoted to the various types of cercariae is excellent and should be revelatory to the average zoologist brought up on liver flukes. Equally admirable is the chapter on the various kinds of life cycles found among the trematodes with reference to the number and type of the intermediate hosts and the encystment preferences of the cercariae. A chapter on the biology of the group gives a fairly inclusive report of the available literature on the behavior and ecological relations of the larval stages, host-parasite relations, and physiology of adult flukes. In regard to the interesting question of the nature of the digenetic life cycle, the author does not mention in the text (although listing the article in the bibliography) the important work of P. D. Chen, published in 1937, which together with other researches practically establishes the theory of polyembryony as the correct interpretation of the life cycle. Other faults of the book are its cursory treatment of the adult anatomy of flukes and the apparent lack of a broad knowledge of the flatworms in general. Thus several characters attributed to the Turbellaria on p. 2 are erroneous: rhabdites are frequently secreted in mesenchymal gland cells rather than in the epidermis; their function is not at all certain; the mouth is frequently anterior to the brain; the ova are frequently enclosed in hard capsules; and the development is indirect in many polyclads. The illustrations, although not too numerous, are simple and clear, and there is an excellent bibliography. The book will have a wide usability among zoologists and parasitologists.

L. H. HYMAN

THE OPERCULATE LAND MOLLUSKS OF THE FAMILY ANNULARIIDAE OF THE ISLAND OF HISPANIOLA AND THE BAHAMA ARCHIPELAGO. *Smithsonian Institution, United States National Museum Bulletin 192.*

By Paul Bartsch. United States Government Printing Office, Washington, D. C. 75 cents (paper). iv + 264 pp. + 38 plates. 1946.

This is the fifth paper in a series dealing with this family of operculate land snails of the West Indies and adjacent islands. The strictly taxonomic treatment limits the value of these articles to other specialists in the field, to whom they will be indispensable.

BIBLIOGRAPHIA ARANEORUM. *Analyse Méthodique de toute la Littérature Arantologique jusqu'en 1939. Tome I.*

By Pierre Bonnet. Les Frères Douladoure, Toulouse. 3000 fr. (paper). 17 + 832 pp.; ill. 1945.

In the preface to this book (Vol. 1 of a projected 3-volume set) Pierre Bonnet frankly states that he regards it as a monument to his industry. When the size of the book is taken into consideration along with the tremendous amount of work involved in completing it, the personal anxieties of the author concerning his own physical condition, and the tribulations resulting from the German occupation, the reviewer is glad to accord fully. This book is a splendid tribute to the author's scholarship as well as to his industry. Bonnet states that all of his spare time for twelve years was necessary to complete his great work. The book was ready for the printers in September, 1940, but he was compelled to wait until January, 1944, to obtain the necessary paper for its printing. Even after the paper became available, his troubles began anew with allied bombings as well as the increased restrictions imposed by the Germans. One can imagine the author's anxieties when he thought his bibliography had been lost because of the requisitioning of the truck by which this part of his book was being transported to the country for safe keeping as well as his great relief when it was sent back to him

by an understanding German soldier. Such are the vicissitudes through which the book passed during its making.

A brief history of araneology is included as a part of the introduction. Seven periods are recognized as follows: Antiquity; Middle Ages, 400–1450; Pre-Linnaean, 1450–1757; Linnaean, 1757–1804; Founders of Araneology, 1804–1850; Golden Age of the Science, 1850–1900; Current Period.

Brief factual biographies are given of 124 araneologists beginning with Clerck. Fifty-seven of these biographies are accompanied by personal photographs collected from many parts of the world. Appended to the biographies is a classification by vocational interests of the workers in this field of science, showing that many vocations and professions besides that of college and university teachers have been represented. Some of these have been physicians, artists, architects, ecclesiastics, business men, and government employees.

Of course, in such a book as this there would be need for some attention to the persistent problems of nomenclature. Bonnet devotes about 65 pages to this part of his book and begins by giving a brief summary of the facts leading up to the adoption of the 10th edition of *Systema Naturae* as the basis of our zoological nomenclature and the fixing of the date when the system became effective as 1758. Then the author gives a strong argument for retaining the names of 55 valid species of spiders described in 1757 by Clerck, who used the binomial method and gave better descriptions than those of Linnaeus. This claim of Bonnet renews an old quarrel, but it deserves a consideration leading to a definite decision in the interests of clarity and stability. In the latter part of this division of the book, the author boldly denounces the evils of those who suffer the unholy ambition to be authors of countless genera and species in order to gain zoological immortality. The work of a distinguished European zoologist is used to illustrate how even very capable workers can be led into shoddy and needlessly repetitive work by this profane zeal.

This reviewer considers that Bonnet's greatest contribution to araneology is his preparation of the extensive bibliography of papers and books on spiders which extends over 410 pages. The bibliography of approximately 8000 items is alphabetically arranged and is preceded by a list of nearly 1400 journals from which the selections have been made.

The last 179 pages of the book are devoted to a meticulous analysis of the bibliography by subjects, under the following general divisions: general and sundry treatments; anatomy and physiology; ecology; geographic distribution; paleontology. The first four of these are subdivided in detail.

In spite of the fact that the paper used in the making of the book is poor and the binding insecure, the volume bears evidence of careful preparation by the printers as well as by the author. Both are to be congratulated for completing a difficult assignment under very trying circumstances. This book will be very useful for araneologists, entomologists, and general biologists. It is a pleasure to have had the opportunity to review it.

A. M. CHICKERING

SHINING HOURS.

By C. N. Buzzard; illustrated by J. Yunge-Bateman. Collins, London.. 10s. 6d. 192 pp. + 8 plates. 1946.

This book contains descriptions, in a conversational way, of the author's observations of honeybees, bumblebees, hornets, the olive fly, and other insects that came to his attention on a small farm in the South of France. These observations are interwoven with descriptions of people and of events with which he was associated prior to the World War II. It is not so much a book on bees as it is of memories of a professional soldier in the English army and of his other experiences in different parts of the world.

The author quotes freely of observations made by Fabre, Lubbock, Von Frisch, Rabaud, and others pertaining to the behavior of bees and ants. His own observations are interesting but usually parallel those of others that have been made in far greater detail and with greater precision. The author obviously enjoys being an amateur beekeeper. His reviews will be found interesting to those who have not had the opportunity of reading the original literature from which they were taken. The illustrations add materially to the value of the book.

J. E. ECKERT

THE BIOLOGY OF THE SOUPFIN (GALEORHINUS ZYOPTERUS) AND BIOCHEMICAL STUDIES OF THE LIVER. *Fish Bulletin Number 64.*

[*By Wm. Ellis Ripley and others.*] *State of California, Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries, Terminal Island.* Free upon request (paper). 96 pp.; ill. 1946.

This bulletin comprises five separate papers, two of which concern the biology of this valuable shark, the soupfin. The remainder are devoted to the oil and Vitamin A content of its liver. A statistical history of the soupfin fishery is presented in some detail. The work on the fishery and life history of the shark was done by Wm. Ellis Ripley of the Bureau of Marine Fisheries of the California Division of Fish and Game, while the biochemical studies were made by René A. Bolomey, V. N. Sycheff and Paul C. Tompkins of the Chemistry Department of Stanford University.

JOEL W. HEDGPETH

FISHES OF THE PACIFIC COAST OF CANADA. *Bulletin No. LXVIII.*

By W. A. Clemens and G. V. Wilby. Fisheries Research Board of Canada, Ottawa. $2.00 (cloth); $1.50 (paper). 368 pp. + 1 plate; ill. 1946.

This is the first comprehensive, one volume treatment of the marine fish fauna of any part of the Pacific Coast. Previous works have concerned the game fishes or other selected parts of the fish fauna, but this work includes all the fish from the insignificant gobies and tide-pool dwellers to the major commercial species. It lists a total of 245 species and provides adequate illustrations for all of them, including an attractive colored frontispiece of a lantern fish. There is a brief introduction, outlining the history of ichthyology in British Columbia and the relationships of the fish fauna of British Columbia to the rest of the Pacific Coast, and giving the general taxonomic anatomy of fishes as an aid to the determination of species. There is also a comprehensive, 27-page key to all the species discussed, a glossary, a bibliography, and an index.

An especially interesting part of the discussion of each species is the brief note concerning the history of that species in the given area, including "first records," and life history data whenever possible. Illustrations of the species are placed in the text along with the discussion, an arrangement which enhances the usefulness of the book and offsets the omission of scales from the figures. Common names have been provided for all the species, but many of these appear to be the inventions of the authors. It is probably inevitable that different fish should be given the same popular name in different parts of the world, but it is unfortunate that "red snapper" should be applied to a *Sebastodes* on the Pacific Coast, when all the rest of the genus are known as "rock-fish."

Until the fish fauna of the entire Pacific Coast of North America is gathered into a single volume, this book will serve as a useful manual for the California coast as well as for that of the Northwest, for many of the species listed range from British Columbia to Southern California.

JOEL W. HEDGPETH

THE BIRDS OF NORTH AND MIDDLE AMERICA. *A Descriptive Catalog of the Higher Groups, Genera, Species, and Subspecies of Birds Known to Occur in North America, from the Arctic Lands to the Isthmus of Panama, the West Indies and Other Islands of the Caribbean Sea, and the Galdpagos Archipelago. Part X. Bulletin 50.*

Commenced by the late Robert Ridgway, continued by Herbert Friedmann. Smithsonian Institution, United States National Museum, Washington, D. C. $1.25 (paper). xii + 484 pp; ill. 1946.

The present part of this exhaustive catalog of the birds of North and Middle America contains the Galliformes. This includes the families Cracidae (curassows, guans, and chachalacas), Tetraonidae (grouse and ptarmigan), Phasianidae (American quails, partridges, and pheasants), Numididae (guineafowl), and Meleagrididae (turkeys).

As in the preceding part, Friedmann has made extensive use of the manuscript notes left by the late Robert Ridgway. The material, however, has been brought up to date and both specimens and literature thoroughly studied. Every taxonomic group, from order down to subspecies, has a detailed description of its morphological characters. For each genus there is provided a drawing of the head, bill, leg, wing, and tail of a member species showing details useful in generic identification. The data given for the species (and subspecies thereof) include the adult male and female, immature, and juvenal plumages, size, range, and a complete synonymy up to 1944.

One error was noted in the keys to the superfamilies Cracoidea and Phasianoidea (p. 4), where the alternate characters given for the two groups were transposed. Otherwise this volume conforms to the excellent workmanship shown in preceding numbers. Concerning the two final parts, Friedmann writes that part XI is ready for press and part XII is in course of preparation, so that we may expect to see the completion of this work in a short time.

HENRI C. SEIBERT

THE MAMMALS OF MICHIGAN.

By William H. Burt. Illustrated by Richard Philip Grossenheider. The University of Michigan Press, Ann Arbor. $3.50. xvi + 288 pp. + 13 plates; ill. 1946.

In the rapidly growing literature on the mammalian fauna of North America this book must rank as one of the most satisfying contributions. The 64 species of mammals, now or within historic times native to Michigan, are systematically listed and thoroughly described. Their taxonomic features, distribution, habits, life histories, and economic importance are enumerated, and this in such a way that the book will appeal to the layman, yet be indispensable for the professional expert. The key for the identification of Michigan mammals is specially noteworthy, since it has been made as simple as possible, is exceptionally clear and serviceable, and can be applied readily by any attentive student.

The mammalian fauna of Michigan is chiefly northern in its relationships, though it also contains southeastern elements. From fossil finds it is known that elephants and mastodonts, giant beavers, peccaries, musk oxen, etc., roamed over Michigan in the remote past. But even in historic times the population of

mammals has changed profoundly, largely in consequence of man's activities. The cutting of forests, draining of swamps, and plowing of land have destroyed or altered many original habitats and thereby reduced or removed the natural ranges of many species. Wolverine, marten, fisher, cougar, caribou, bison, and elk exist no longer within the state, though the elk has recently been re-introduced. Wolf, lynx, and moose, formerly ranging throughout the state, have become restricted to a very limited area. The opossum, however, rare previous to about 1900, is today quite abundant and the prairie mole, striped ground squirrel, deer mouse, and cottontail have recently invaded Michigan, following the clearings northward.

The volume contains a chapter on "Collecting and Preparing Specimens" which is excellent for beginners and potential collaborators in future studies on Michigan mammals. A useful Appendix tabulates for each species the chief bodily and cranial measurements in adults, the gestation period, the number of litters per year and young per litter, the longevity, the size of the home range, etc. The numerous well-drawn text figures and maps of distribution are instructive and clearly printed. Thirteen colored plates of different Michigan mammals, painted by R. P. Grossenheider, will delight every nature lover. The index was prepared with the same thoroughness as the rest of the volume.

A. H. Schultz

How to Hunt North American Big Game. *Olympic Editions.*

By C. E. Hagie. The Macmillan Company, New York. $2.49. xii + 195 pp.; ill. 1946.

Here is a good book for the hunter. Novices will be particularly interested in the several chapters dealing with general information on the important phases of a hunting trip. These are full of useful suggestions covering such topics as the selection of suitable territory, proper dress, handling of game, and action to be taken in common emergencies.

All hunters, novice or otherwise, will find the chapters covering the various kinds of game animals useful, as these not only describe the habits of these animals in a general way but describe specific methods of hunting in each case.

Hagie writes in a clear, concise style and has selected a variety of pertinent photographs, both of which points add to the value of the book.

J. Cushing

Know Your Cat.

By John Hosford Hickey and Priscilla Beach. Harper & Brothers, New York and London. $2.50. xvi + 251 pp. + 16 plates. 1946.

Since this is a second edition, *Know Your Cat* must have met with considerable success, presumably from cat fanciers rather than biologists. The style is banal and sentimental. Approximately a quarter of the book is devoted to breeds and showing, of interest only to a specialized audience. A quotation will illustrate the volume's limitations:

"Many people make the mistake of scolding their pets or referring to their faults or misdemeanors in front of people. This they consider smart to do, little realizing the pain they are causing their pets, which often results in their becoming surly or disobedient."

On the credit side the book contains 24 very handsome photographs of cats and kittens.

The book ends with Murphy's Cattage, "a brief biographical dictionary of cats in literature or owned by literary or historical personages." Most of the references are to very obscure personages indeed, but this section makes interesting reading in the same way as do the Common English Christian Names, in Webster's *Dictionary*.

Ann Moment

ECONOMIC ZOOLOGY

Hunting North American Deer. *Olympic Editions. By Arthur Hawthorne Carhart. The Macmillan Company, New York.* $2.49. viii + 232 pp. + 16 plates. 1946.

Although the hunter who reads this book will learn a lot about hunting, even if already experienced, its value is not restricted to hunters nor its subject matter to the killing of deer. Rather, here is to be found an excellent exposition of the science of game management applied to a given animal, combined with a discussion of the practical value of this science to the hunter and illustrated by a variety of specific examples.

The result is that the writer shows there are no magic formulae for the conservation and killing of deer other than those developed by experience, common sense, and the use of scientific method. Carhart does not leave the reader up in the air, however, but opens the way to a variety of definite ways in which these factors can be developed. In doing this he uses a style that achieves a nice balance between the danger of being either too technical or too general.

In addition, the point of view of the sportsmen-naturalists who founded and developed game management principles is interwoven with the subject matter in a way that commends itself to the attention of non-hunting naturalists and conservationists as well as to sportsmen.

J. Cushing

ANIMAL GROWTH AND DEVELOPMENT

A Class Book of Practical Embryology for Medical Students. *Oxford Medical Publications.*

By P. N. B. Odgers. Oxford University Press, London, New York, and Toronto. 7s. 6d. 63 pp.; ill. 1945.

This little book consists of labelled drawings of twelve sections of the 6 mm. pig embryo, fourteen of the 10 mm. pig, one diagram showing the location of the sections in the embryo, and one showing the vascular relationships of the fetal liver. Each section is accompanied by a brief explanatory note.

Once again the question arises of why authors and publishers alike do not insist on appropriate titles. There is nothing in this book of "practical" embryology concerning any technique except the interpretation of prepared slides.

GAIRDNER MOMENT

A LABORATORY MANUAL OF VERTEBRATE EMBRYOLOGY. *Revised Edition.*

By Roberts Rugh. Burgess Publishing Company, Minneapolis. $2.25 (paper). x + 229 pp.; ill. 1946.

Embryologists will welcome this revised and enlarged edition of an unusually comprehensive and well illustrated manual that is virtually a textbook. Especially noteworthy are new sections that give a complete, labelled set of 10 mm. pig sections, directions for artificially inducing ovulation in anurans, and directions for preparing whole mounts of chick embryos.

GAIRDNER MOMENT

THE STORY OF HUMAN BIRTH. *Pelican Books. Revised Edition.*

By Alan Frank Guttmacher. Penguin Books, New York. 25 cents (paper). x + 214 pp.; ill. 1947.

This Pelican Book is a revised edition of the author's *Into This Universe*, published ten years ago (cf. Q. R. B. 12: 360. 1937). It has been shortened almost one-half and brought up to date, and as a result seems a finer book than ever. The discussion of normal, as contrasted with abnormal, conditions seems better balanced. Certain sections have been rewritten "in a didactic way," to quote the author, "so that they may act as a guide for the pregnant woman. Ten years ago I carefully avoided this, but ten additional years of active practice have persuaded me that a readable advice-book has its place, particularly when cheap and readily available." Some new sections such as the short account of erythroblastosis foetalis and the Rh blood types, do not appear to have been added to the index.

Bits of the history of obstetrical medicine have been happily blended with present scientific knowledge to make a most interesting and readable account. Evidence has been carefully weighed. The book is a fine addition to the literature "for the millions."

BENTLEY GLASS

ANIMAL MORPHOLOGY

FUNCTIONAL ANATOMY OF THE MAMMAL. *A Guide to the Dissection of the Cat and an Introduction to the Structural and Functional Relationship Between the Cat and Man.*

By W. James Leach. McGraw-Hill Book Company, New York and London. $2.50. viii + 231 pp.; ill. 1946.

This book promises to be extremely useful for its avowed purpose, viz., to serve the needs of students "particularly in nursing, health, and physical education where opportunity to do human dissection may be lacking or limited." Which is not to say that it could not be used in the mammalian part of a course in comparative vertebrate anatomy. The sections on the skeleton and on the muscles are the best and by far the longest in the book. The text is clear, interesting, and well organized, especially in respect to muscle action. The comparative anatomist will inevitably think the student's understanding of muscles would have been even further clarified had there been some consideration of epaxial and hypaxial, of branchial and hypobranchial muscles, with all which that implies regarding innervation and functional groupings.

The numerous illustrations are well chosen, clear, and include several by Tom Jones. After the section on muscles, directions for dissection in succeeding sections are general rather than of the minute, step by step type found in most manuals. The student should profit by being thus cut loose from stereotyped cook-book methods.

A question inevitably arises about the title of the book. The subtitle does a good job in indicating the nature of the book. The book succeeds well in living up to the subtitle. Then why so pretentious and misleading a title, several sizes too large for the scope of the book?

GAIRDNER MOMENT

CE QU'IL FAUT SAVOIR EN DISSECTIONS. *Manuel pratique à l'usage de l'Etudiant et du Naturaliste. Savoir en Histoire Naturelle, Volume IX. Guides Techniques du Naturaliste, Volume II.*

By P.-H. Fischer. Paul Lechevalier, Paris. 52 fr. (paper). 203 pp. 1942.

This little volume is number nine of a series on natural history, and is volume two of a series of technical

guides for naturalists. It pretends to give elementary instructions to guide a beginner in the dissection of various types of animals. Within 186 pages the author covers the entire animal kingdom, from protozoans to mammals, and accompanies his text with a large number of line drawings. The latter are hasty and rough, and in company with the text give an impression of extreme superficiality. The subject covered is too large for the scope of a single handbook, and its execution is poor.

JAMES M. SPRAGUE

A HANDBOOK FOR DISSECTORS. *A William Wood Book. Second Edition.*

By J. C. Boileau Grant and H. A. Cates. The Williams & Wilkins Company, Baltimore. $2.50. xii + 390 pp.; ill. 1945.

This volume differs from the first edition in that it is not intended primarily to be used with the author's earlier text, *A Method of Anatomy*. It has been rewritten as an independent dissection manual, and for that reason should have wider use. This text makes no attempt to be complete in itself, as does, for example, Cunningham's *Manual of Practical Anatomy*, and must be used with an atlas. Only ten schematic line drawings are present, and this partly explains the shortness of the text. The index is unfortunately short, although the volume is well bound and the price reasonable.

JAMES M. SPRAGUE

HANDBOOK OF MICROSCOPIC CHARACTERISTICS OF TISSUES AND ORGANS. *Third Edition.*

By Karl A. Stiles, with an introduction by Melvin H. Knisely. The Blakiston Company, Philadelphia. $1.75. x + 214 pp. 1946.

The new edition (cf. Q. R. B. 18: 290. 1943) includes a number of additions which deal with cells and mitosis, osteogenesis, the oral cavity, the tongue, teeth, hair and nails, and the taste organs. The glossary has been greatly enlarged, and a bibliography has been added.

It is rather unfortunate that the newly included material on the cell perpetuates the concept of the linin network, now known to be an artifact, and speaks of the changing of the chromatin-linin network into the chromosomes, which are present all the time. This is a minor point, but in an outline such as this the exclusion of the needless is an important consideration.

The outline will undoubtedly serve very well its intended purpose as a supplement to regular textbooks of histology, most of which are, as Stiles says, overgrown reference books. My own students have found the outline, with its minimum of pictures and its blank pages for drawings and notes, most helpful.

BENTLEY GLASS

NOTES ON MICROSCOPICAL TECHNIQUE FOR ZOOLOGISTS. *By C. F. A. Pantin. Cambridge, at the University Press; The Macmillan Company, New York.* $1.50. viii + 75 pp. 1946.

Every user of this little handbook ought to find many helpful suggestions in it and will probably be mildly surprised at certain omissions. One such surprise is that clarite has not become known at Cambridge. The book makes no pretensions of completeness, but represents a selection of those general methods that have over the years proved themselves in the laboratory of the Department of Zoology at Cambridge University. The very virtue of the book is its smallness and freedom from confusing alternative procedures. The section on general methods has all the customary procedures and includes the preparation of frozen sections as well as paraffin- and celloidin-embedded sections. Those special methods given are limited to a few for the nervous system, cytoplasmic inclusions and specific cell constitutents, protozoans, and a few others. There is a useful appendix giving the composition of a variety of body fluids in invertebrates and vertebrates and directions for making isotonic and buffered solutions to suit. There are two indexes, one for subjects, the other for person's names.

BENTLEY GLASS

ANIMAL PHYSIOLOGY

THE PHYSIOLOGICAL BASIS OF MEDICAL PRACTICE. *A University of Toronto Text in Applied Physiology. Fourth Edition.*

By Charles Herbert Best and Norman Burke Taylor. The Williams & Wilkins Company, Baltimore. $10.00. xiv + 1169 pp. + 3 plates; ill. 1945.

This standard physiology textbook, now in its 4th edition, was first published in 1937. There have been, in all, 11 reprintings of it, in addition to one Spanish and two Portuguese editions. Such a record is eloquent testimony to the widespread popularity of the book, and suggests that it fills a very definite need in the medical literature. Its distinguished authors have endowed the book with a distinct and original personality, which may be appreciated by reference to the Preface to the First Edition, in which the authors' aims are stated. It is there pointed out that whereas physiology is a science in its own right, it is especially desirable for a medical school text to emphasize those

aspects of the subject which will throw light upon disorders of function. The hope is expressed that the book will serve to link the laboratory and the clinic, and will promote continuity of physiological teaching throughout the pre-clinical and clinical years of the undergraduate course.

The 1,169 pages represent approximately a 40 per cent reduction from the 1,942 pages of the Third edition. This has been accomplished, with no abridgement of the text, by completely resetting the type in a new two-column format, employing larger pages and smaller type. On the whole, these changes make for easier reading and easier handling, and the reduction in the size of the figures has not impaired their clarity. The book is solidly and attractively bound. The subject matter is arranged in nine sections, dealing in order with blood and lymph, circulation, respiration, secretion of urine, digestion, metabolism and nutrition, endocrines, nervous system, and special senses. The space allotted to these various sections appears to be judiciously apportioned; most sections are of about 100 pages, while three, those on circulation, metabolism and nutrition, and the nervous system, are enlarged to between 147 and 181 pages. It will thus be noted that the authors have not expanded the material in their own fields of special interest out of proportion to legitimate demands of the subject, a situation not too common among physiology texts. Each major section is subdivided into a considerable number of chapters, an arrangement which seems to this reviewer to be unfortunate. It has the effect of compartmentalizing the information offered and of impairing the continuity of the presentation. It contributes also to the book's encyclopedic nature, since there is a wealth of detailed information with little attempt to emphasize subjects of particular interest or importance, a point which will be referred to again further on. A further unfortunate aspect of the arrangement of the material is that the entire bibliography appears at the end of the book, where it is broken up into the references for each of the 81 chapters. In order to locate a reference in the course of reading the text, one has first to turn back to the first page of the chapter to find the chapter number, which is given in Roman numerals. With or without translation into Arabic, the reader has then to thumb through the fifty-odd pages of references until he locates those for the designated chapter. Your reviewer has made these maneuvers for a number of years and has not enjoyed the experience. Furthermore, the difficulty is one which might be readily avoided by listing the references at the end of each section or chapter.

As to the factual content of the material presented, this reviewer has few comments to offer other than the opinion that on the whole it is adequate and includes much recent material. The section on Intracellular Oxidation and the Biological Transformation of Energy has been ably rewritten by A. M. Wynne, Professor of Biochemistry at the University of Toronto. Commendation is offered for including the chart of the interrelationships of the phosphorylating, glycolytic, and respiratory systems taken from Potter's 1944 review in *Advances in Enzymology*. However complex and confusing this may be to the beginning student, it is certainly one of the best diagrams of these relationships. A section on the physiology of skeletal muscle is, unfortunately, notably lacking. There is a brief section on cardiac muscle, but the remaining material on muscle is scattered throughout the book. This is probably done in order to de-emphasize the attention given this subject in many courses in mammalian physiology. Even so, the desirability of relegating to a footnote the discussion of such a fundamental physiological concept as the motor unit may be questioned. Even today, with perhaps some justification, many physiology laboratory programs begin with muscle-nerve physiology, so that the lack of suitable treatment of this material is at once evident to the student and his instructors. There is, furthermore, material on the pathological physiology of muscle, particularly as encountered in physiotherapy practice, which might properly be included.

It appears more pertinent to discuss the extent to which the book fulfils its stated aim of helping to bridge the gap between the clinical and preclinical aspects of the subject. It is the opinion of your reviewer, supported by the wide popularity of the text, that the book represents quite the best effort yet put forward in this direction. Unhappily, however, there appear to be several respects in which the accomplishment falls short of the goal. Mention has already been made of the encyclopedic character of the book. Little effort is made to organize the very considerable (if not overwhelming) mass of information in such a way as to direct the student's attention to those phases of the subject which are of particular importance on either theoretical or practical grounds.

Rather more serious is the criticism that the lack of emphasis and orientation, characteristic of the whole work, extends into the clinical phases of the subject in such a way as seriously to impair the value of the book as a means of introducing the student to clinical medicine. When the student has been grounded in the basic facts underlying an understanding of physiological mechanisms, he ought then to have presented to him the answers to the following questions. First, what is the range of normal variation in the function under consideration? Is this a feature of behavior that is normally held within rather narrow limits, or is it notoriously variable? In either case, what factors particularly account for such variations as are encountered in average populations, and to what extent is it possible, for diagnostic purposes, to draw sharply-defined limits as to what is normal and what is not?

Second, what are the common deviations from normal for which he, as an inexperienced physician, should be particularly alert and which he may be expected to encounter early in his clinical experience? What mechanisms are responsible for these abnormalities, and what significance should accordingly be attached to them? Having thus prepared the student for the important needs of the immediate future, it might then be proper to entertain discussions of the more bizarre abnormalities, uncommonly encountered, but perhaps of particular physiological interest. Such a presentation of the material might be expected to orient the student with respect to his approaching clinical studies, and it would appear unlikely that students so introduced to the subject would fail to appreciate the true value of their training in physiology.

An example from the present text will illustrate how the material is actually handled. In the chapter (II) that deals with the red blood cells, under the heading "Physiological Variations in Number of Red Cells," we meet first a discussion of the polycythemia encountered at high altitudes, followed by paragraphs on the effects of muscular exercise and emotional states, heightened environmental temperatures, and other conditions. Similarly, under the heading "Alterations in the Number of Red Cells in Pathological States," there is a list of various diseases in which the red count is elevated, and a longer discussion of polycythemia vera. One must then turn to Chapter IX before finding a discussion of the anemias. A scheme for classifying the anemias is first offered, followed by discussions of hypochromic anemias, pernicious anemia, etc. One notes no introductory discussion of the range of normal variations of the red count in the two sexes. No suggestions are offered as to what might constitute contributing factors for such variations, and the question of whether or not an abnormality in the red cell count is sufficient to warrant investigation or treatment is not raised. No emphasis is made in the section on hypochromic anemias that these are far and away the most common abnormalities of the red blood cell level encountered in general practice, nor is it pointed out that this condition is very largely restricted to women in a particular age group, a circumstance to which the physiological event of menstruation is an important contributing factor. Perhaps this example will suffice to indicate the extent to which the book seems to fall short of the maximal attainment of its stated aims. One may reiterate, however, that in spite of such criticisms as have been offered above, the book holds a preeminent place in the medical literature, and one which it justly deserves.

CHARLES O. WARREN

YOUR BODY. *How It Is Built and How It Works. The Thinker's Library, Number 59. (Science Section).* *By D. Stark Murray. Watts & Company, London.* 2s. viii + 103 pp.; ill. 1936.

When this reviewer was in Junior High School, he was given a course in Physiology. The text was very poor and his knowledge was consequently scant. The present volume would have corrected that condition. It is a simple presentation that would benefit youths of 13–15 years. Accompanying the text are illustrations that are simple, yet adequate, for this purpose.

Murray has stressed the physiological function of the human body and has expressed this function from four viewpoints: (1) by giving a clear conception of the body's functions; (2) by presenting the enormous variability of the human race; (3) by endeavoring to place man in relation to the rest of the evolution of living things; and (4) by giving an outline of the evolution of man's body.

This book is too simple for adults, but for a junior high or first year high school student it is most commendable.

E. H. HERRON

BLOOD GROUPING. *Annals of the New York Academy of Sciences, Volume XLVI, Art. 9.* *By William C. Boyd, J. W. Cameron, L. K. Diamond, Philip Levine, M. Melin, J. L. Oncley, Louis Pillemer, D. A. Richert, Eve B. Sonn, A. S. Wiener, and Ernest Witebsky. New York Academy of Sciences, New York.* Paper. Pp. 883–992. 1946.

This series of papers is a result of the Conference on Blood Grouping held at the New York Academy of Sciences May 18 and 19, 1945. Following a general Introduction by Boyd, the papers fall into two groups, those principally of serological interest and those principally of genetic interest. The first group includes four papers: Isolation and Purification of Blood Group A and B Substances; Their Use in Conditioning Universal Donor Blood, in Neutralizing Anti-Rh Sera, and in the Production of Potent Grouping Sera, by Witebsky; Methods for the Preparation of Anti-A, Anti-B, and Anti-Rh Isoagglutinin Reagents, by Oncley et al.; Isohemagglutinin Titer and Avidity, by Pillemer; and The Assay of Blood Grouping Sera; Variation in Reactivity of Cells of Different Individuals Belonging to Groups A and AB, by Boyd. The second group includes two reviews: Genetic and Constitutional Causes of Fetal and Neonatal Morbidity, by Levine; and The Rh Series of Genes, with Special Reference to Nomenclature, by Wiener.

LYMPH. *Annals of The New York Academy of Sciences, Volume XLVI, Art. 8.*

By Philip D. McMaster, Robert Chambers, Eliot R. Clark, Thomas F. Dougherty, Cecil K. Drinker, William E. Ehrich, Eugene M. Landis, Valy Menkin, Paul A. Nicoll, Richard L. Webb, Abraham White, and B. W. Zweifach. The New York Academy of Sciences, New York. Paper. Pp. 679–882 + 14 plates; ill. 1946.

This is the full report of the New York Academy of Sciences Conference on Lymph, under the chairmanship of P. D. McMaster, containing the papers presented and the ensuing discussion. This is a most interesting and stimulating book, covering a field too much neglected by most physiology texts and courses. The physiologist will find the material suggestive and fascinating. As is inevitable in books of this kind, the logical development of ideas, except within the scope of the individual papers, is absent. Rather, it is a presentation of many points of view, some of them conflicting. It is therefore not a book for the casual or even semi-casual reader, although anyone actively engaged in the teaching of physiology will find much in it of profit, and not only in the field of lymphatic circulation.

Investigators concerned with water balance, endocrinology, immunology, permeability, and general circulatory physiology will find this discussion particularly worth-while. Reports of this sort enable workers in widely scattered areas to keep abreast of the recent trends, and fill a definite need so long as readers appreciate that the authors are discussing concepts still in a fluid state and are not necessarily committing themselves to final and definitive positions.

It is impossible to discuss, or even to mention all the points of view brought out. Considerable emphasis is placed upon the intermittency of capillary blood flow. In this connection the demonstration of an intermittent uptake of fluid from the tissue spaces by blood makes an interesting correlation. Some of the more important concepts regarding the significance of the size and shape of protein molecules, in relation to their ability to pass through membranes, are well discussed. A detailed statement concerning accurate measurements of interstitial pressure and its variations under physiological conditions fulfils a long-felt need. The normalcy of extra-vascular protein and the importance of the lymph flow in returning this to the blood deserves the emphasis it receives. The increasing recognition of the adrenal cortex, and its role in maintaining plasma protein and the development of antibodies, is fully presented. In this connection a summary of the present status of the problem dealing with the fate of the lymphocytes and their importance in the bodily economy is highly pertinent.

DIETRICH C. SMITH

BIOCHEMISTRY

ANNUAL REVIEW OF BIOCHEMISTRY. *Volume XV. Edited by James Murray Luck; Associate Editors, James H. C. Smith and Hubert S. Loring. Annual Reviews, Stanford University P. O., California.* $5.00. xiii + 687 pp. 1946.

The *Annual Review of Biochemistry* for 1946 shows the effect of the curtailment of publication and distribution of scientific papers during the war. The quality of the reviews has not suffered, but the reviewers in several fields have been handicapped in their attempts to achieve complete coverage. As in normal times, most of the reviews in this volume tend to take the form of annotated bibliographies, but this appears to be a consequence of the attempts to review a large volume of literature in a minimum of space.

The chapter on biological oxidations and reductions, by Elliott, is a good summary of recent work on iron-porphyrin and other metal-containing enzymes. It includes also a review of work on flavo-protein enzymes, pyridine-nucleotid systems, and a section on inhibitors. The sections on the reactions concerned in metabolic cycles, and on cell and tissue metabolism are added features. The 200 papers on non-oxidative enzymes were reviewed by Wynne in 33 pages. Recent work on choline esterase was well represented (4 pages). Some of the references on the inhibitors of choline esterase are, however, already behind the times. The chapter on plant carbohydrates is concerned primarily with the synthesis and breakdown of "amylase" and "amylopectin," the recently discovered components of starch.

References on crystalline myoglobin, hemoglobin, and other proteins are to be found in the chapter by McMeekin and Warner. Of interest from a phylogenetic point of view is the reference to hemoglobins found in the body walls and perienteric fluid of *Ascaris lumbricoides* var. *suis* and to a hemoglobin-like protein isolated from the nodules of soy beans. Recent work on the denaturation of proteins is also covered in this chapter.

Dutcher and Guerrant have contributed an excellent survey of recent work on the vitamins. They point out that in spite of the war, or perhaps partly because of it, at least 1,000 papers relating to different phases of vitamin research have been published during 1945. The Food and Nutrition Board of the National Research Council played an important role in this work. Many of the researches in this field are directly traceable to questions raised by the Army, Navy, and other governmental agencies which were responsible for food distribution during the war period. The reviewers state that the outstanding trend in the field has been toward the papers dealing with synthesis. Of special note is the synthesis of folic acid and conversion of beta carotine to vitamin A.

Protozoologists, as well as enzymologists and mycologists, will find that much valuable and useful information is summarized in the chapter on the biochemistry of yeast, by Carl Neuberg. The review of the work in immunochemistry, by Kabat, covers a subject of interest to many biologists. In addition to references to the immunochemistry of viruses, bacteria, and pollens, there is a timely discussion of recent work on the Rh factor and other blood group antigens.

The chapter on organic insecticides may be of interest to entomologists. General biologists and others with a desire to learn of the latest reports on DDT and other more recently discovered insecticides, will want to consult this review. The last chapter, on the inactivation and detoxication of pressor amines, reflects Hartung's interest in the relationship between chemical structure and physiological activity. Biologists in general, if they wish to read this, should plan to do it with a chemical dictionary in one hand, an organic chemistry in the other, and sleeves rolled up.

The review on viruses, by N. W. Pirie, has been saved for the last word because it is so refreshingly different. It is a gem, since it is not the usual annotated bibliography but is a critical and profound analysis presented in an interesting and readable style.

FRANK H. J. FIGGE

AMINO ACID ANALYSIS OF PROTEINS. *Annals of The New York Academy of Sciences, Volume XLVII, Art. 2. By William H. Stein, Reginald M. Archibald, Erwin Brand, R. Keith Cannan, Hans T. Clarke, John T. Edsall, G. L. Foster, Stanford Moore, David Shemin, Esmond E. Snell, and Hubert B. Vickery. The New York Academy of Sciences, New York.* $2.25 (paper). Pp. 57-240. 1946.

The several papers presented at a discussion of the "Amino Acid Analysis of Proteins" under the auspices of the New York Academy of Sciences (1946) and here reprinted, emphasize principally the application of new methods to this old problem. The contributions of pure chemical analysis, the isotope dilution technique, chromatography, microbiology, enzymology, and physical chemical methods are presented briefly but authoritatively. For the first time, certain simple proteins have been characterized in terms of their amino acid residues, a truly formidable task, involving, in the case of beta-lactoglobulin, twenty-eight independent determinations, but successful, in that the entire molecule is apparently accounted for. The important question of primary standard proteins was raised but seemingly left open by the conferees.

H. R. CATCHPOLE

THE FIRST TWENTY-FIVE YEARS OF THE AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS.

By Russell H. Chittenden. The American Society of Biological Chemists, New Haven. $1.50. vi + 109 pp.; ill. 1945.

Chittenden states that among the membership of the American Physiological Society when it was organized in 1887, only two of the 28 members were primarily interested in physiological chemistry. By 1906 the number of members of the Society had increased sufficiently to suggest the idea that it was desirable for them to form a separate society. Twenty-nine charter members then adopted Articles of Agreement and launched the American Society of Biological Chemists.

At the request of the Council of the Society and the Editors of the *Journal of Biological Chemistry*, Chittenden undertook to prepare a history of the Society through its first twenty-five years. He has done an excellent service in so doing, and the book is a worthy memorial to the man who introduced physiological chemistry into America.

The author gives an account of the early development of the chemical aspects of physiology, of the organization of the Society, and brief biographies of some of the most notable among the charter members. Then follows an interesting account of each successive meeting of the society, the officers and new members elected, and his comments on those papers presented which created greatest interest. Photographs of the men who have been presidents of the Society are reproduced. An account of the founding of the *Journal of Biological Chemistry* and its history make the book highly interesting reading to all who are interested in the growth of biochemistry. In the interval of forty years the membership of the Society has increased to 714.

E. V. MCCOLLUM

HEALTH AND DISEASE

ACTIONS AND USES OF DRUGS. *A Textbook for Nurses. By Windsor C. Cutting. Stanford University Press, Stanford University.* $3.00. xiv + 326 pp.; ill. 1946.

In this book for nurses an attempt has been made to harmonize the teaching of the pharmacological action of drugs and their therapeutic application. Those drugs are grouped together which may be used for the same disease. In this way the author's aim was to make more obvious the therapeutic application of a specific class of drugs. Wherever necessary for proper understanding of a drug's use, the abnormal physiology of the disease is reviewed.

The author makes a plea for simplification of the

teaching of pharmacology and therapeutics, and to this end he has eliminated all archaic materia medica. The text reflects this viewpoint by limiting the subject matter to only the most important of the drugs that the nurse will encounter in her professional duties. Interestingly enough, the list of drugs still remains staggeringly large.

Cutting has accomplished an excellent task in writing this book, and there is little doubt that it will be well received by many nursing schools throughout the country. The volume appears to be free from errors. One could only wish for a more complete and satisfactory index, a valuable and necessary adjunct to a text in this field.

C. JELLEFF CARR

THE PRINCIPLES AND PRACTICE OF TROPICAL MEDICINE. *By L. Everard Napier. The Macmillan Company, New York.* $11.00. xviii + 917 pp. + 22 plates. 1946.

Napier's textbook on tropical medicine is one of many, newly introduced texts and equally as many older works in this field which have enjoyed a tremendous increase in interest during the late war. All too many of these books have been written by medical men who have spent the greater portion of their practising years in temperate or even in the frankly colder climates of our northern cities. Some have, in the course of their recent military experience, observed for at least a limited period, some of the tropical diseases upon which they write with considerable verbosity. The author's book, unlike these, is based on more than a quarter of a century's residence and practice in the more tropical portions of India and upon a considerable travel in other sections of the tropics.

This work consists of forty-one sections preceded by a double-page frontispiece in color, a table of contents, and a preface by the author. The general arrangement is based upon clinical symptomatology, diseases with similar manifestations being considered together, irrespective of the biological nature of the etiologic agents. This is in keeping with the aim of the book, that of offering a clinical aid to the student, practitioner, and public health worker. Individual sections are outlined and indexed, a feature which in the reviewer's opinion might just as well have been omitted, since the sections are usually fairly short. The first fifty pages of the book deal with climatic effects as related to tropical diseases. This is an all-important phase of the general subject that, in many similar texts, is glossed over in a few words, but which the author covers admirably and succinctly. Also wisely included and equally well discussed are sections on nutrition and nutritional diseases, on snakes and snakebites, and on rabies, which appear at the end of the book. The remainder, the bulk of the 867 pp. of text, is concerned with the epidemiology, etiology, clinical pathology and symptomatology, treatment, and to an admittedly lesser degree, with the laboratory diagnosis of the author's selection of those infectious diseases which he feels are especially prevalent or which present a particular problem in strictly tropical latitudes.

The section on kala azar, like many others in the book, is profusely illustrated with photographs and diagrams, largely original with the author. Some in that particular section are from Napier's earlier book on kala azar, which was published in Calcutta in 1927; others are entirely new. The chapter dealing with cholera is especially interesting and includes a detailed discussion of the methods of treatment in the Indian area of endemicity.

The classification of amebiasis which the author proposes is contrary to the more generally accepted concept. The idea of including amebiasis sine dysentery as a complication of amebic dysentery seems to be a case of "putting the cart before the horse," since amebic dysentery can hardly exist without there first being a less dramatic underlying pathological degeneration leading to such symptoms. It is also difficult to understand the author's reason for stating, "[The author] considers that the adoption of this classification will help rescue tropical medicine from laboratory domination." Most clinicians agree that amebiasis may and frequently does simulate almost any clinical syndrome known to man, and that a purely clinical diagnosis is a most unreliable approach. Accurate diagnosis, as well as the establishment of a cure, must be based upon the laboratory demonstration of the causal organism or on a demonstration of its systemic effects by serological or other laboratory methods. It seems strange that there should be an appeal for rescuing tropical medicine from laboratory influence, whether this (as the author would indicate) be domineering or not.

Napier's statement that "the finding of active trophozoites with contained red cells, or undoubted precysts, is diagnostic of amebic dysentery" might well have been further modified. Many trophozoites of *E. histolytica* fail to show red cells in their cytoplasm when observed in freshly passed stools. While it is true that they frequently do contain such inclusions, they also commonly do not. The author's use of the phrase "undoubted precyst" is also an unhappy one, since the precyst is one of the most difficult stages of the parasite upon which to base a definite differential diagnosis. Finally, as the author indicates in a footnote to his Table IX, *E. coli* trophozoites may, at least in culture, ingest red cells. Napier has failed to mention, however, that although it is not common, they have been shown to ingest red cells in vivo (Tyzzer and Gieman, 1938). Most exemplary is the emphasis which the author gives to the sometimes prolonged

and often unwarranted dosage with emetine chloride in the treatment of amebiasis.

The author's use of Kessel's diagrams of cysts and trophozoites of the intestinal amebae, without bothering to include the explanatory notes originally accompanying these figures, is hard to reconcile with his earlier objection to the use of the term amebiasis to refer solely to an infection with *E. histolytica*. That the reader should understand the morphological differences exhibited by the various amebae pictured in the diagrams seems of more importance to the reviewer than that one should attempt to correct at this late date the loose usage of a term which has come to have an accepted connotation in medical literature. Equally unexplainable is the fact that the author makes a mere mention of the zinc sulfate flotation technique under the heading of the laboratory diagnosis of amebiasis, where, if he chose to discuss it at all, he might well have given details. Later, in describing the laboratory diagnosis of hookworm disease, he mentions the zinc sulfate technique in connection with methods for uncovering very light infections. Actually, this method is no better for uncovering such infections with helminths than any other reliable flotation technique, while its original proponents (Faust et al.) do feel that it offers a valuable adjunct to diagnosis of protozoan infections, being particularly useful in uncovering light infestions with intestinal amebae.

The sections dealing with helminthic infections of man, although not given as much space as those infections in which the author has been more vitally interested, are nevertheless concisely and thoroughly presented. The discussion of filariasis, like some other sections of this book that deal with conditions which might be thought of as "medical diseases of war," could very well have been made more timely had the author included some of the more recent experiences of the Americans as well as of his countrymen, the British, who had considerable contact with tropical medicine in the South Pacific theatre of operations.

The frontispiece, though decorative, seldom achieves scientific accuracy. The figures are generally diagrammatic, although some attempt has been made to picture the parasites as they theoretically appear in the usual laboratory preparations. Particularly subject to these objections are the eggs of the helminths and the quadrinucleate cyst of *E. coli*, a rare stage in fecal smears.

The book is provided with both subject and author indexes, which are quite adequate. The volume is attractively bound, and is printed in large, clear type on a fair grade of paper.

ALAN C. PIPKIN

A MALARIOLOGIST IN MANY LANDS.
By Marshall A. Barber; foreword by Paul F. Russell. University of Kansas Press, Lawrence. $2.50. xii + 158 pp. + 4 plates. 1946.

This little book presents a roughly chronological narrative of Barber's personal experiences in malarious areas around the world during a lifetime of fruitful work. It achieves rather more than that which the author indicates is his aim in the preface, for although it was written, as an effort toward education, in a popular style, it is rich with scientific information concerning the epidemiology and control of malaria under a multitude of conditions. It should be interesting to professional as well as lay readers. The foreword, for the benefit of readers who do not already know of the author and his valuable contributions to malariology, is in form of an introductory note to acquaint the lay reader with the author's colorful background.

The book consists of thirteen chapters, the first twelve of which deal with as many separate geographical areas making up a malarious belt around the world. The volume is carefully and interestingly written, modestly revealing the author as a humanitarian as well a scientist of the highest type. While all of the chapters offered vitally interesting material for the reviewer because of his own malaria control experiences as a Navy malariologist in the late war, the most exciting account seemed to be in Barber's description of the remarkable fight which has been won against *Anopheles gambiae* in Brazil. This experience actually occurred after he had formally retired from active participation in that world-wide program of public health work which has been for many years and is still being carried on by the Rockefeller Foundation. While this was a sort of "postman's holiday," the author's experiences show that, as long as he is able to tramp through mosquito-ridden swamps and streams, he will be carrying on the battle to exterminate malaria as one of the most notorious maladies known to man. The last chapter presents a challenge to future generations to carry on this fight.

The book is provided with a convenient and adequate index. The half-dozen or so illustrations, while good, seldom approach the clarity of Barber's interesting theme.

ALAN C. PIPKIN

PSYCHOLOGY AND ANIMAL BEHAVIOR

PSYCHOLOGY FOR THE MILLIONS.
By A. P. Sperling. Frederick Fell, New York. $3.00. xiv + 397 pp. 1946.

The title gives the author's purpose: to write about psychology so simply and interestingly that the large mass of moderately educated people will be reached. The author has done that well. He has written simply

and directly, in a fast pace, and with interesting illustrations. He has an excellent knowledge of psychology, not only of the standard textbook material but also of significant recent researches in the field. He covers much of the basic material in an introductory text, but livens it up by a never-ending array of illustrations from real life and people, usually well-known people, such as prize-fighters, artists, musicians, and circus artists.

This blending of sound fact and interesting illustration can be seen in a few sample chapter headings: "Gershwin, Whistler, Marble, Deisler, Jones—Sensory Champions" or "Seeing, Hearing, Tasting, Smelling, etc.—Man's Eleven Senses"; "From Carnegie Hall to the Flying Trapeze" or "Heredity and Environment among Athletes and Performers"; "Consumers and Criminals are Caught by their Emotions" or "The Psychology of Emotions"; "Two-Gun Crowley and Adolph Hitler" or "The Psychology of the Psychotic Personality"; and "Quiz Kids and Phi Beta Kappa Men" or "The Intelligence Quotient and Personality."

This is an interesting and instructive book for anybody to read. The academic psychologist will find it reasonably accurate—accurate enough to raise no serious objections—and he will find many applications of psychology with which he probably was not familiar. Indeed, it is an excellent book from which to draw illustrations for teaching psychology at the undergraduate level. Other scholars in the sciences, who would like their psychology sugar-coated, can read this book for both instruction and amusement. And then the millions for whom it was written—they have a book which they can read, which they will enjoy, which will give them a fairly good idea of what psychology is all about.

C. T. MORGAN

PSYCHOLOGY OF INFANCY AND EARLY CHILDHOOD. *McGraw-Hill Home Economics Series. Third Edition. By Ada Hart Arlitt. McGraw-Hill Book Company, New York and London.* $3.75. xiv + 475 pp. 1946.

This is a well organized, clearly written textbook covering the developmental processes in children as they have been ascertained through a variety of experimental psychological studies. The author has done quite well in her expressed aim to avoid the pedantic approach, into which it is so easy to lapse whenever, as so often, it is necessary to draw on highly technical or statistical data. However, Ada Arlitt's personal experience with infants and pre-school children gives her a vantage point from which to offer interpretive and illustrative material that does much to leaven the atmosphere of the book and lift it out of the laboratory into everyday life.

The first few chapters are practically standard—comprising an introduction to psychological methods, and consideration of heredity, the organic heritage, and the basic emotional make-up of the individual. Her treatment of these topics must necessarily seem somewhat routine to anyone familiar with the field, but her presentation is not stereotyped. From these first chapters she goes on to cover such interesting phases of child development as habit formation, learning, memory, imagination, thinking processes, forms of expression in children, individual variations in the young child, and special problems which may turn up in childhood.

Ada Arlitt successfully manages to make her material interesting and practical not only for psychology students but also for intelligent parents or teachers who wish sound information on early child development. The book is basically for the classroom, however, as is evidenced by the traditional list of exercises for the student at the end of each chapter and the weighty bibliography which inevitably follows.

HELEN HEWITT ARTHUR

RELIGION. *Its Functions in Human Life. A Study of Religion from the Point of View of Psychology. McGraw-Hill Publications in Psychology. By Knight Dunlap. McGraw-Hill Book Company, New York and London.* $3.50. xii + 362 pp. 1946.

For almost the first time, a serious attempt has here been made to study the relation between religious life and normal human activity. As Dunlap has pointed out in his preface, the usual "psychology of religion" has merely emphasized some rather obvious similarities between the phenomena of conversion or mystical experience and the phenomena of certain pathological states. Here is a book that undertakes to relate religious systems and practices to daily human living.

Dunlap describes the various kinds of moral and cosmological systems that have been called religions and shows how their particular form has grown from the knowledge and needs of their time and place. A large and important mass of information has been culled from the fields of anthropology, archeology, and religious history to be brought together in their present form for the first time. Many of the facts and theories brought to light in this volume had previously been hidden from the general reader in specialized monographs.

A factual, objective account of similarities and differences among religious systems has resulted from Dunlap's method. In addition, the economic and social background of the founding and growth of religious practices has been traced, frequently in con-

siderable detail. There can be no doubt that this is a valuable contribution. The work should be extremely useful as a text-book in a wide variety of courses: anthropology, ethics, sociology, history, social psychology, religion, and even on occasion economics. One may safely predict that it will take its place among the most important and widely used of secondary sources in the field of religious science and history.

Two somewhat minor criticisms are in order. First, the historicogenetic thesis tends to overbalance some other considerations that psychologists may wish had been given more consideration. Dunlap has frequently reiterated the view that most "explanations" of religious practices are ad hoc rationalizations for rituals that were already in existence and whose original purpose and origin had been forgotten. That is an important and justifiable point, well worthy of repetition; but many students of behavior will consider that the origin of the rationalization is as important as the origin of the rite—and perhaps farther-reaching in its implications for the understanding of religious motivation. Dunlap's general position seems well and succinctly summarized in a typical passage, as follows: "A Christian in love is apt to pray that his affection may be returned and his yearning satisfied. He may also pray for success in the stock market, for new clothes, for healing from disease, or for a bicycle. *These attempts to satisfy desires through religion have no bearing on the explanation of religion and its development*" (italics reviewer's). But of course they may have a great deal of bearing on the "explanation" of why that particular individual is religious and how his religion affects his other behavior. The clinical approach to religion which has led to such gross theoretical excesses has at least the virtue of trying to investigate the very real problem of individual (as opposed to institutional or group) religious life.

Second, Dunlap's kind of genetic approach is itself non-psychological. That is to say, he attempts to show the effect of practical conditions in each society on the form of religion that has developed, but the causal hypotheses are common-sense in nature; they are not linked to modern theories of behavior-dynamics in any way. This fact gives the book the flavor of history rather than of psychology, and the work will consequently be less stimulating to professional psychologists than if Dunlap had not shunned the admitted danger of "psychologizing" about the social developments with which he deals.

W. C. H. PRENTICE

PERSONAL ADJUSTMENT.

By Knight Dunlap. McGraw-Hill Book Company, New York and London. $4.00. xii + 446 pp. 1946.

Under ordinary circumstances, books on psychological adjustment, mental hygiene, and the like deserve no more than passing notice in a scientific journal. There are, however, two reasons for giving more extended treatment to the present volume. First, Knight Dunlap has established himself as an original contributor to psychological fact and theory. When he presents a book on a psychological subject, he is sure to be heard. The general reader may reasonably expect that the book's contents represent laboratory findings or, at the very least, the considered opinion of those most familiar with the major research in the field. Second, the author has encouraged that expectation by his vehement and repeated remarks about 'armchair theorists,' the frequency of his use of the term being such that one without special training in the field could arrive at only one conclusion, namely that the facts presented in this book are based on the soundest of data.

Confronted with such a situation, the reviewer feels impelled to treat the work on its own footing—as a contribution to the science of psychology. Unfortunately, the book turns out to have no merit whatsoever when viewed in that light. In fairness to the author, it should be pointed out that *Personal Adjustment* presents in book-form a series of lectures originally designed for undergraduates; yet even considered as a practical course, the book must be adjudged a failure. The "facts" and "principles" that are here exposed to view comprise personal prejudice, attested scientific knowledge, intelligent insight, misinformation, practical advice, and truism in approximately equal proportions. Some of the ex cathedra statements that are made by this self-styled opponent of armchair theory are worthy of specific citation. They probably speak for themselves.

"The first presentation of the modern theory of heredity was in the chapter on 'Social Progress and Eugenics,' in the book called *Civilized Life*, by the present author, published in 1934."

"By destroying brain cells in the cerebrum the (metrazol or insulin) shock treatment makes the person infantile and thus more easily controlled."

"Appliances which are to be inserted into the vagina before coitus are not effective, in spite of their recommendation by birth-control clinics."

"Some of my greatest 'peeves' have been against obstetricians who, because of an armchair theory, have refused to allow the mother to nurse her baby."

"We do know that previous homoerotic practices are responsible for certain cases of female frigidity."

"Most neurotics are vegetarians and have been vegetarians for the greater part of their lives."

"Schools infected with the virus of 'progressive education' treat all children as if they were low-grade morons."

The list could be extended almost indefinitely. Page after page contains statements for which there

is no evidence, for which the original evidence has been discredited, in which cause and effect have been confused, or in which Dunlap's social and scientific prejudices come between the reader and the truth.

For classroom purposes, this book is potentially useful as an omnibus of what to avoid in the study of personality and adjustment. The volume gives no evidence that the author is even dimly aware of the need for applying genuine scientific standards to information concerning personal adjustment; and while some sections are undoubtedly sound and others most entertaining, the total effect of the book is certainly harmful to a field which is already characterized by work that is sadly lacking in rigor.

W. C. H. PRENTICE

SOCIAL CORRECTIVES FOR DELINQUENCY. *Yearbook National Probation Association 1945.*

Edited by Marjorie Bell. National Probation Association, New York. $1.75 (cloth); $1.25 (paper). vi + 328 pp. (1946).

This yearbook of the National Probation Association for 1945 is a compilation of articles on special problems of crime, delinquency, and correctional programs. These have been assembled under eight headings that give some coordinating pattern to what really impresses one as being a rather heterogeneous collection of papers. The feeling of lack of unity within the volume is caused primarily by the extreme range in the quality of the papers rather than by any inherent cross-currents of ideas. A few of the papers are exceedingly well done, but others are so particularly diffuse, verbose, and unscientific that the general effect is spoiled, at least for anyone taking up NPA literature for the first time.

Of the papers this reviewer found worth-while, two appear in Section I, entitled "The War and the Offender." Both these papers deal with constructive correctional programs developed in the armed services. One is about "The Army's Rehabilitation Program for Military Prisoners" and the second concerns, "Training Wayward Sailor Men for Return to Duty." The latter, despite the revivalist flavor of its title, is a good exposition of the trend away from sheer punitive discipline of minor offenders.

Section II is given over to some historical research in the annals of the treatment of crime, while Section III is devoted to "New Approaches in Treatment." In the latter group appears a most interesting article by O. H. Close on "California Camps for Delinquents," in which he holds out the hope that these camp programs for an active, healthy, out-door life may offer a solution to the problem of rehabilitating our delinquent youth, a problem which is certainly one of our most pressing social issues today.

Section V has two papers on "Probation in Practise." Section VI, on "Professional Language," could well have been omitted altogether. It is composed of one interminable, would-be spritely essay about "The Semantics of Social Work." Sections VII and VIII, being reports on legal developments of the year and on the functioning of the NPA for the year 1944–1945, respectively, are doubtless of interest only to members of the Association.

Altogether, this is not a volume wholly to be dismissed as something only for criminologists and probation officers. It reveals a trend, expressed in a number of the papers, toward a growing recognition of and desire for modern social work and modern psychotherapy handling in crime and delinquency. People in these related fields should become better acquainted with the problems posed by the National Probation Association.

HELEN HEWITT ARTHUR

ADULT ADJUSTMENT OF FOSTER CHILDREN OF ALCOHOLIC AND PSYCHOTIC PARENTAGE AND THE INFLUENCE OF THE FOSTER HOME. *Memoirs of the Section on Alcohol Studies, Yale University, Number 3. By Anne Roe and Barbara Burks, with a chapter on sibling adjustment in collaboration with Bela Mittelmann. Section on Alcohol Studies, Yale University, New Haven.* $2.00 (paper). xii + 164 pp. 1945.

This is a study made of 78 carefully selected subjects to ascertain, if possible, the effect of heredity on the subsequent adult adjustment of children placed in foster homes before the age of ten. Of these 78 subjects, 63 had parents who were either definitely alcoholic or psychotic, and 25 were children of normal parents. The background data, gleaned from records of the State Charities Aid Association for New York, showed that there were some statistically significant differences in the placement of the two groups, in that children of alcoholic or psychotic parentage were usually removed from their own home environment at a little older age and were put into less desirable foster homes than was true for the children of normal parentage. However, despite this, the children of the deviant parentage succeeded as adults in making life adjustments which were considered quite as adequate in general as adjustments made by children of normal parents. Therefore, from this study, the conclusion may be drawn that alcoholism and psychosis are not directly inherited.

The authors then examined the relationship between the foster environment and the subsequent life adjustment of all the children. Of particular interest are the observations on children who turned out well in spite of the combined handicaps of poor heredity, early

mistreatment, and placement in an unsympathetic foster home.

Altogether this is a scholarly and thoughtful paper. It is more than a statistical and methodological *tour de force*. It is a compilation of relevant data which is then assessed for meaningful conclusions and possible interpretations. Studies like this contribute to our greater understanding of people and the factors which influence development.

HELEN HEWITT ARTHUR

PSYCHIATRY FOR YOU.

Edited by Robert V. Seliger. Oakridge Press, Baltimore. $1.25. 64 pp. 1946.

This is a very small volume whose purpose is, to quote the editor, "to set forth in general terms to the average reader what is actually meant in everyday language about certain treatments, diagnoses, and personality illnesses." Robert Seliger has done this through the medium of posing a typical question and then giving the authoritative answer—very much in the tradition of certain syndicated news columns along the same line. In this somewhat stilted fashion twenty-nine topics, ranging from psychoanalysis, graphology, and brain waves to colitis, alcoholism, and the inferiority complex are disposed of in an average of one and a half short pages each.

While there is no doubt that modern psychiatry can bear elucidation in non-technical language for the enlightenment of the masses, it is hard to believe that this little book answers the need. The material is unimaginatively presented, the subject matter is by no means complete, the style is ponderous, and the sentence structure is occasionally so involved as to be actually misleading.

HELEN HEWITT ARTHUR

TECHNIQUE OF PSYCHOANALYTIC THERAPY.

By Sandor Lorand. International Universities Press, New York. $4.50. viii + 251 pp. 1946.

This is an interesting and thoughtful book written by a man who is not only an experienced clinician but also a teacher. He has chosen a difficult subject to write on, for, as he himself states in his opening chapter, "the technique of psychoanalytic therapy cannot be learned from books and lectures alone." However, he makes a considered attempt to cover a number of the problems which confront the young therapist and to describe, if not definitive solutions, at least the attitudes which the therapist may find most helpful in handling such problems.

Lorand makes a rather sweeping survey of the general field involved in psychoanalytic treatment. He takes up the issues of interpretation, of patients with anxiety and phobias, of patients with sexual difficulties, of compulsion neurosis, character neurosis, and neurotic depressions, of dream analysis, the problems of counter-transference, and the always puzzling matter of the termination of psychoanalytic treatment Since this is not a long book, and Lorand uses in many instances the device of presenting a single illustrative case, it is apparent that he has not developed his ideas in particular detail. Perhaps this is an asset, however, for too didactic an approach to the subject of treatment might be unfair to the student who, in the long run, must eventually find his own way of dealing with specific issues within the general framework of analytic concepts.

Lorand is master of a very readable style. He also has a knack of couching a provocative point in a rather casual phrase and, at first glance, he may give the impression of having written a fairly superficial volume. While he has not written a classical text, it is true, the material he presents seems to be sound, and this book may well be considered a useful adjunct to the library of the student analyst.

HELEN HEWITT ARTHUR

SHOCK TREATMENTS *And Other Somatic Procedures In Psychiatry.*

By Lothar B. Kalinowsky and Paul H. Hoch; foreword by Nolan D. C. Lewis. Grune & Stratton, New York. $4.50. xiv + 294 pp. 1946.

This is an exceedingly compact volume in which the joint authors attempt to survey the entire field of shock treatment. It is not a definitive, encyclopedic text on the subject but rather a comprehensive outline of historical, theoretical, practical, and scientific facts (or reasonable assumptions) about shock treatment. Both Kalinowsky and Hoch have had considerable clinical experience with shock treatment in New York State institutions and have contributed research papers on the topic for a number of years. They seem eminently qualified to present this material, and they do so with a minimum of superfluous verbiage.

After a short introductory chapter on the historical background, the authors give a thorough but concise review of insulin-shock treatment and the convulsive therapies, with main emphasis on electric convulsive therapy. These two sections comprise approximately three-fourths of the book, which is quite appropriate in view of the important role these two organic therapies play in modern institutional psychiatry. The problems of selecting patients, the actual techniques of administration, the possible complications, associated medical and laboratory data on patients undergoing treatment, prognosis, and statistical results are among

the phases of the subject which are competently covered. The last one-fourth of the volume is devoted to reports on "other somatic nonsurgical treatments," i.e., continuous sleep treatment, fever therapy, vascular shock, and so on. One chapter is assigned to prefrontal lobotomy and its relationship to shock therapy. Chapter VII, which serves to round out the survey, is given over to a brief discussion of the theoretical considerations of shock treatment.

Altogether this is an extremely useful outline to have available. It should be perused even by psychiatrists who perhaps do not endorse shock treatment but who should at least be accurately informed of the tremendous modern trend toward this still highly controversial therapy. It is the sort of book which is practically a "must" for psychiatrists in state hospital practice.

Kalinowsky and Hoch state that they have tried to present this survey objectively, without undue enthusiasm or skepticism. Indeed, their book is surprisingly free from any gross evidence of weighted judgment. However, it is plain to see (and certainly quite understandable) that the authors strongly approve of shock treatment. Their attitude somehow permeates even the careful factual presentation and makes their book quite persuasive for the continued use and development of shock treatment, although admitting at the same time that we know very little, so far, about why or how shock treatment works and just what "a cure" means in the convulsive therapies.

HELEN HEWITT ARTHUR

THEIR MOTHERS' SONS. *The Psychiatrist Examines an American Problem.*

By Edward A. Strecker. J. B. Lippincott Company, Philadelphia and New York. $2.75. 220 pp. 1946.

This is a long essay devoted to an exposé of what Strecker has chosen to call the "Great American Mom" and her eroding influence on the ultimate growth and maturity of her children, particularly of her boy. According to Strecker a great majority of our NP casualties in the past war represented men with Mom-induced emotional soft spots which made them incapable of independent, mature action in the face of even minimal difficulties. In many cases the all-engulfing effects of "Momism" made it impossible for men even to leave home in the first place without disturbing anxiety reactions, and so Mom contributed materially to the 1,850,000 who were rejected at the induction centers for neuropsychiatric reasons.

The mother who over-protects her son, who never teaches him the give and take of real life, who shelters him from thinking and acting independently, who, in short, chokes him with ever constricting emotional apron strings, is a Mom. Her boy can never be a man, in the true sense of the word. At the other end of the scale, as proposed by Strecker, is the Mother, whose major purpose is not to entwine her children helplessly to her but is rather to teach them the steps of independent growth so that when they reach adulthood they will be really mature, capable of leading their own lives fully and constructively. *Her* sons won the war and have something to contribute to the peace.

The author points out that there may be many Moms or Mom-surrogates—the "Mom in pants" or over-indulgent father, "Mom in a bottle" or the dependence of an immature fellow on stimulants, and so on. He also develops the idea that our modern civilization actually puts a premium on the Mom, being apparently blind to the real effects of women who "do everything" for their sons. Song, story, and neighborhood sentiment play up the "self-sacrificing" woman who through studied effect, in any number of ways, succeeds in emasculating her boy and keeping at least a major part of him for ever for herself.

Strecker has something important to say in this volume. He addresses himself earnestly not only to women who may have sons but to all who deal with children and who have been amazed and shocked by the NP casualty rate in the ranks of our modern young men. However, he issues a warning against the tragic effects of Momism with such intensity that the sensitive reader may feel, as he closes the book, as if he had been shaken until his teeth rattled. Perhaps that is what the reader needs. Yet he may leave more impressed with Strecker's own emotional vituperations about the problem than with the actual ideas which prompted the outburst.

HELEN HEWITT ARTHUR

LECTURES ON PSYCHOANALYTIC PYSCHIATRY.

By A. A. Brill. Alfred A. Knopf, New York. $3.00. x + 292 + xiv pp. 1946.

In this volume Brill presents a chatty, highly personalized and vivid account of the early developmental history of psychoanalysis and the basic Freudian concepts of psychodynamics. The author first organized his material in 1924 as a lecture course, which was subsequently repeated for fourteen consecutive years (1929–43) as part of the post-graduate work in Neurology and Psychiatry at the College of Physicians and Surgeons, of Columbia University; and he gives the course to his reading public now as if it were being delivered from the lecture platform. This device creates a most informal atmosphere, which is pleasant but might possibly be somewhat misleading to a serious young student.

There are ten lectures altogether. These begin with a generalized survey of psychiatry as Brill knew it in

the early 1900's. His personal acquaintance with Bleuler, Jung, Pierre Marie, and Freud lends a delightful anecdotal air to his description of this historic period. From this base, his lectures progress, with many casual digressions, to cover the psychoanalytic postulation of the Id, Ego, and Super-ego structure, the theory of the neuroses and psychoses, and the phases of psychosexual development as Freud outlined them. Throughout, the author liberally illustrates with case histories the clinical application of his points.

Brill has a very fluent style, which makes this book extremely readable and probably made the original lecture course exceedingly well attended. His material is accurate and clearly stated but not profound. The reader already well oriented in psychoanalysis will be diverted but not particularly stimulated by these 'lectures.' Perhaps the volume could more correctly be entitled "Introductory Lectures in Psychoanalytic Psychiatry," since it is clearly the interested but not particularly well-read student to whom this book will be most worthwhile.

HELEN HEWITT ARTHUR

A GENERAL INTRODUCTION TO PSYCHO-ANALYSIS. *A Course of Twenty-eight Lectures Delivered at the University of Vienna.*

By Sigmund Freud. Authorized English translation of the revised edition by Joan Riviere, with a preface by Ernest Jones and G. Stanley Hall. Liveright Publishing Corporation, New York. $2.49. 412 pp. + 1 plate. 1935; (1947).

A most welcome addition to the attractive Black and Gold Library. This is a book, whether one regards Freud as scientist or not, that every biologist should own.

UNDERSTANDING HUMAN NATURE.

By Alfred Adler. Translated by Walter Béran Wolfe. Introduction by Leland A. Hinsie. Greenberg, New York. $2.00. xiv + 286 pp. 1927; (1946).

Another reprint of a classic of psychoanalysis. Greatly inferior in typography, paper, and binding to the reprint of Freud's masterpiece just noticed, it is nonetheless worth adding to the bookshelf to occupy a place beside it.

HUMAN BIOLOGY

SEX AND THE SOCIAL ORDER.

By Georgene H. Seward. McGraw-Hill Book Company, New York and London. $3.50. xi + 301 pp.; ill. 1946.

This book represents a worthwhile and ambitious attempt to analyze the role of sex in modern society after approaching the subject from an evolutionary point of view. An introductory chapter broadly defines sex as "the social role of male and female in the life of the group as well as mating behavior"; and the biological, cultural, and clinical interpretations of sex are described.

There follow six well-documented chapters dealing with neural and hormonal factors involved in the courtship, mating, and parental behavior of various vertebrates, from fish to chimpanzee. Patterns of reproductive behavior are described with particular emphasis upon the fact that in many species sexual behavior is affected by surrounding conditions, such as possession of a nesting territory, or individual rank in the social order of the group. It is suggested that advancing phyletic status is generally accompanied by increase in the degree to which sex behavior is affected by social factors.

Comparisons of the role of sex in various primitive societies bring out the tremendous importance of cultural channelization. In Trobriand society sex operates as a constructive social force. An indulgent attitude toward sex play in childhood makes for early emotional maturity and obviates any sudden and traumatic transition at puberty. In adulthood, sex has an influential role but does not dominate all aspects of individual or community life. Among the Marquesans sex serves as a compensation for basic insecurities from an uncertain food supply and other factors. Under such conditions it is responsible for much frustration and maladjustment. The author suggests that study of the effects of widely different attitudes toward sex in other societies should provide data for intelligent revision of sexual mores within our own culture.

A brief historical survey shows that the social status of women in Western culture has periodically fluctuated from complete subjugation to near-equality. The existence of obvious biological differences between the sexes has often been made the excuse for a denial of equal social rights, although there is no scientifically admissable evidence to indicate innate differences in the capacity for learning or ability to contribute to social progress outside the home. In the closing chapter a plea is made for a clear distinction between the biological and the social roles of the sexes in modern society. It is held that fundamental biological differences need not and should not be allowed to result in unequal social opportunities. Both sexes should contribute intellectually, emotionally, and economically to home and family; and in the community there should be a similar equality of opportunity and responsibility.

The book is well illustrated, extensively indexed, and includes a very useful bibliography of 700 items.

FRANK A. BEACH

PSYCHOLOGY AND WORLD ORDER. *Pelican Books. By Ranyard West. Penguin Books, Harmondsworth, Middlesex, and New York.* 1s. (paper). 125 pp. 1945.

This little book is in a sense an extension of the ideas advanced a few years ago by the author, a British physician and social psychologist, in his book *Conscience and Society* (cf Q. R. B. 19: 172. 1944). In an effort to elucidate the existing state of national and international frustration, he starts his enquiry into the psychological causes of war and peace "by considering the emotions which ordinary people show when they are dealing with each other in large and powerful groups." Our human tendency to over-emphasize differences in otherwise similar things is one source of difficulty. That we see other's faults and our own real or imagined virtues is another. We are also prone to assume unconsciously that superficial resemblances between persons or groups imply deeper ones, and we project our emotions from one object onto another. The discussion of the bases of prejudice is particularly good. The argument as to the nature of law and its psychology, which follows, is derived from West's earlier book. "Men need externally administered law," he says, "not because their consciences are weak, but because their prejudices are strong, while outside their established societies men need externally administered law for both these reasons. . . . Good law . . . exists to express and to implement our physical, mental and spiritual needs by preserving that balance between the demands of our self-assertive and social instincts which we have agreed upon as necessary to our common social life." It is clear that this definition implies democracy. The author emphasizes that all law depends on force.

Chapter Five is a thought-provoking study of loyalty and power in group and nation, and from this the argument proceeds to a consideration of international psychology and the error inherent in regarding states as persons. The whole cogent and coherent argument then comes to a head in the consideration of our present well-nigh mythical international law and the compelling need for a World Order, preferably a World Federation, that would be based on real law backed by force and superseding purely national sovereignties.

This essay was written before the United Nations Charter was framed at San Francisco. It exhibits remarkable foresight, as well as insight, into world conditions and world needs, and is a fine example of what may be achieved by applying psychological principles to even the gravest and most difficult of human problems.

BENTLEY GLASS

THE HUMAN FRONTIER. *A New Pathway for Science Toward a Better Understanding of Ourselves. By Roger J. Williams. Harcourt, Brace and Company, New York.* $3.00. x + 314 pp. 1946.

This book is worthy of the attention of every biologist. In simple terms that should be intelligible to everybody, it sets forth the need for investigating individual human beings in a scientific program,—for founding a new science of humanics that will consider the variance of humankind as well as the character of the so-called "average man."

There can be no doubt that this point of view needs emphasizing. A large part of *The Human Frontier* is devoted to a consideration of how much better it would be to regard the individual variables rather than to lump everyone together according to the average. Facts from studies of fundamental metabolism, of sight and other senses, of endocrine activity, and of a variety of other physiological traits, as well as from psychology, are selected to illustrate the point. The rest of the book develops the theme of those values that would accrue from an applied science of humanics, values such as increased tolerance, improved mental hygiene, religious and educational values, better mutual adjustment in marriage, better social adjustment and less criminality, a broadened, individualized medical practice, more effective medical and biological research, better understanding of leaders and leadership, better guidance in the choice of life work, and, last but not least—one may hope—better international understanding. The knowledge that people are so diverse that even the great man is ordinary in some—perhaps in many—respects and that the ordinary man—each one of us—is most likely possessed of at least some traits superior to those of the great man, ought to increase both self-respect and tolerance. It ought further to lead to the strengthening of our democratic foundations through a heightened estimate of the worth of diversity and the uniqueness of the individual.

All this is true—yet the author has perhaps overemphasized the scientific significance of the individual in his zeal. If there is to be any scientific prediction at all, there must be generalization and abstraction. If every man differed in every possible way from every other man, no science of humanics would be possible. It is because of common characteristics and "averages" that scientific prediction is possible. What the author really means, no doubt, is that, in the language of the biometrician, less attention should be given to means and other averages and more to the variance. Put in these terms, Williams' argument is not so novel—at least among biologists with a genetic point of view (see, for example, Julius Bauer's *Constitution and Disease*, a classic in this field; reviewed, Q. R. B. 20: 381. 1945). Nevertheless, in many fields variance has been largely or wholly ignored, and the author's plea for a new approach is wholesome.

Biologists will do well to consider the implications of *The Human Frontier* at the present moment. It ought to be possible to use a study of this kind as a chart and guide in planning some of the work to be

carried on under the National Science Foundation, if that becomes a realization. The author is especially to be commended because such a book as this, appealing to the layman, is particularly calculated to create general understanding of the importance of scientific research as a social function and to win support for such legislation.

BENTLEY GLASS

AMERICA: 1355–1364. *A New Chapter in Pre-Columbian History.*

By Hjalmar R. Holand. Duell, Sloan and Pearce, New York. $4.00. xiv + 256 pp. + 12 plates. 1946.

In 1895 there was excavated near the village of Kensington, Minnesota, a stone on which was carved a somewhat lengthy inscription in runic writing purporting to tell the story of a Norse expedition to interior America in the year 1362. The immediate reaction of scholars to this find was to designate it a forgery, but in the years that have passed since its discovery evidence in support of its authenticity has been slowly accumulating, so that today opinion is about evenly divided.

The author of the work here under review has done more than anyone else to integrate this evidence, and in the opinion of the reviewer has amply proved his case. But acceptance of the Kensington runestone as authentic is only the beginning of the solution of the mystery which it commemorates. One wants to know what Norsemen were doing in Minnesota in the fourteenth century, how they got there, and what became of them.

It was to answer questions of this sort that Holand began a search that led him into most of the libraries of Europe, including that of the Vatican. He has examined every artifact from northern Minnesota and southern Canada which might conceivably be of Scandinavian origin, and he has called in archeologists and geologists to help him track down every rumor of a mooring stone that has ever come to his attention. Some of these he discarded as false clues; others he has accepted. The bibliographies at the ends of his books, of which this one is the third, are of such magnitude that even those skeptics who reject his conclusions are forced to respect his erudition.

In 1942, Philip Ainsworth Means published his *Newport Tower*, a book in which he attempted to overthrow Shelton's theory that this ancient edifice was the base of a windmill dating from the colonial period, and to attribute it instead to the Norsemen. It is true that Means does not commit himself as to whether it was erected by the earlier colonists of Vinland in the eleventh century, or by the party who set up the Kensington stone in the fourteenth century, but either of these alternatives presents difficulties. If the Kensington Norsemen had gone directly west from Greenland, as it is natural to assume they would have, their path would have crossed Hudson's Bay, as the runic inscription seems to indicate. But then the mention of Vinland in the inscription would be a problem. If Vinland be identified with Newport it would be difficult to explain a circuitous route around Labrador in preference to the more natural one up the St. Lawrence.

The purpose of the present work is to reconcile the author's earlier books with that by Means. The author accepts the theory that the Newport tower was a medieval church and attributed both it and the Kensington stone to the Paul Knutson expedition, which was lost in the wilds of America in the years which give its title to the book. According to the author, the path of this expedition across Minnesota is marked by a series of drilled rocks, which so closely resemble the mooring stones in use in Norway today that he concludes that they served the same purpose. The fact that many of them are not now located on navigable water is not a serious objection to the theory, for there is ample geological evidence to show that the lake levels were formerly higher than they are today. But there are other difficulties.

For instance, the author tells us that the stones are found only on lake shores and never along rivers, where they would not be needed. One would think that on a swiftly flowing current a secure mooring place would be more necessary than on slack water. Also, in a country like Norway, settled through a long period of historic time, where boats may be moored night after night in the same locality, drilled stones would be helpful, but it is difficult to imagine a small group of twenty men fleeing across an unknown wilderness to escape the merciless savages who had already massacred one-third of their party, yet taking time to drill a rock every night where they knew they would never camp again.

Some of these drillings may be of recent origin, but enough of them have authentic histories going back to the eighteen-seventies when there were no white settlers in this part of the state to compel the belief that they are the work of pre-Columbian Europeans, the Indians knowing nothing of the art of drilling stones. But it is not so clear that they were intended for mooring stones. One boulder contains four such drillings, and is interpreted as an altar, the holes serving to support the canopy used during celebration of the mass. But although we know that at least one priest accompanied the expedition, and that mass was probably celebrated on many occasions, four holes seem pretty slim evidence on which to base so complicated a theory.

The fact that in 1629 and in 1634 the Pilgrim settlement was called New Plymouth in order to distinguish it from Old Plymouth, as Newport was known in

those days, is not conclusive evidence of Norse occupation, as the Pilgrims were preceded by a number of unsuccessful attempts by the British to colonize New England, of which the Popham expedition was the oldest and the best known. The Newport tower may have been erected by any of these. What is needed at Newport is excavation of the ground beneath and surrounding the tower under competent archeological supervision. Pending such an investigation speculations as to the origin of the tower can add nothing of value to the evidence in support of the authenticity of the Kensington stone. The fact that the latter was erected by travelers from Vinland means nothing, for the descriptions in the sagas of the locality of that country are hopelessly vague, and there is no reason to suppose that the term was not used generically, just as the English used the name Virginia to apply not only to the colony by that name, but to the entire coast from Florida to Nova Scotia.

This book is well written and is full of interest. It has a bibliography of 176 items and an index of 6 pages.

ALL THESE PEOPLE. *The Nation's Human Resources in the South.*

By Rupert B. Vance, in collaboration with Nadia Danilevsky. The University of North Carolina Press, Chapel Hill. $5.00. xxxiii + 503 pp. 1945. This is a highly technical analysis of the demography of that part of the nation which today shows the most rapid rate of population increase—the southeastern states. For the purpose of this study the area is defined as those states lying south of the Ohio and Potomac rivers, together with Arkansas and Louisiana, but excluding West Virginia.

During the war years the natural tendency of migration has been from rural to urban districts, and as the region under consideration has only one large city, the movement of its people has been out of the region rather than into it. Yet despite this fact, the vital index of these people is so high that they more than hold their own in population.

It is not likely that this work will have any very large appeal to the reading public outside of those highly specialized groups who study demography and economics. Statistics of the nature of those which make up the bulk of this work are rather dry reading. Yet this must not be construed as saying that the book is unimportant. On the other hand, it is highly important that attempts be made to collect the kind of data embodied in this study and to digest them, and that not only in the southeast but elsewhere as well.

A careful attempt to digest the nearly 300 maps, charts, and diagrams set out in this work will do much to clear up some of the popular misunderstandings of the economic features of the southeastern states. For instance, it is a well known fact that they spend less per capita on education than does the nation as a whole. But it is not so well known that the actual expenditure on education by these states constitutes a significantly larger proportion of their total income than in the other states. This is because the southeast is deficient in that sine qua non of a high standard of living, viz., wealth. Not that these states are devoid of resources, but that no attempt has been made to exploit them scientifically, outside of the Tennessee Valley Authority.

The difference between industrial situations in the southeast and elsewhere is aptly illustrated by the fact that Birmingham, in which the steel industry of the south is concentrated, is frequently spoken of as the Pittsburgh of the South. No one would ever think of calling Pittsburgh the Birmingham of the North. A similar statement might be made about the manufacturing cities of High Point and Grand Rapids. The point is that wealth attracts industry and industry attracts labor. We therefore find the industrial plants situated in the north and the migration of labor is toward these manufacturing centers and away from the south, and until this emigration of labor can be stopped by sensible and legitimate means the southeast will be unable to develop its resources.

A chain can be no stronger than its weakest link. As long as the nation as a unit pursues an economic policy which keeps part of it in economic subjection, just so long will that part remain the breeding ground of intolerance, prejudice, and suspicion, and no nation can enjoy the fruits of freedom while one of its states is saddled with the problems of illiteracy.

To correct this situation economic planning is needed on a national scale. Today economic planning is unpopular because we have had so much of it that is bad. But a lack of good planning may be just as deleterious as a surfeit of bad planning. According to the author, the southeastern states are pervaded by a feeling of insecurity. The southerners feel that military victory will bring to the northern and western states a prosperity which they themselves may not share. In the closing chapter the author summarizes what he thinks the southeast needs, and makes suggestions as to how the desired ends may be achieved, at the same time reminding the reader of the fate of the nation which is half slave and half free, and of the house which is divided against itself.

SIERRA POPOLUCA FOLKLORE AND BELIEFS. *University of California Publications in American Archaeology and Ethnology, Volume 42, No. 2.*

By George M. Foster. University of California Press, Berkeley and Los Angeles. 75 cents(paper). Pp. 177–250. 1945.

DE OMNIBUS REBUS ET QUIBUSDEM ALIIS

PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY *Held at Philadelphia for Promoting Useful Knowledge. Volume 90, Number 5, December 27, 1946.* This number of the *Proceedings* contains two articles of biological interest: Analysis of some Phylogenetic Terms, with Attempts at Redefinition, by Otto Haas and G. G. Simpson; and The Gene (Penrose Memorial Lecture), by George W. Beadle.

ROCKS.

By William Alphonso Murrill. Published by the author, Gainesville, Florida. $1.00 (paper). 62 pp. 1946.

This booklet, prepared for Girl Scouts doing nature study, should succeed well in its intended purpose of awakening interest in young people. In Part I, a considerable amount of geology and paleontology is woven into a story. In Part II, there is a more formal outline of historical geology. Part III is a description of common rocks, minerals, and precious stones.

STARS.

By William Alphonso Murrill. Published by the author, Gainesville, Florida. $1.00 (paper). 41 pp. 1946.

This is a booklet prepared for Girl Scouts. The first part tells in story form some of the legends behind the naming of the constellations. Part II is a brief outline of the stellar universe; Part III gives brief descriptions of the 25 principal constellations.

C. S. I. R.—1945.

By G. Lightfoot. Council for Scientific and Industrial Research, Melbourne, Australia. Free upon request (paper). 98 pp.; ill. 1945.

This well illustrated brochure outlines the work of the Australian Council for Scientific and Industrial Research in a non-technical style intended for wider distribution than the regular Annual Reports. Among the contents of biological interest are summaries of work in plant industry, entomology, animal health, animal nutrition, forest products, food preservation, fisheries, and dairy products.

WEISS MAGNETONS AS COMPONENTS OF NUCLEAR AND SUBNUCLEAR STRUCTURES.

By Theodore van Schelven. Kosmos Publishing Company, Amsterdam, Holland. $3.00. 34 pp. + 5 charts. 1945.